R-3825-8

TECHNICAL MANUAL

OPERATION AND MAINTENANCE

J-2 ROCKET ENGINE COMPONENTS HANDLER EQUIPMENT

INCLUDING RELATED ENGINE COMPONENT REMOVAL AND INSTALLATION PROCEDURES

(ROCKETDYNE)

THIS PUBLICATION HAS BEEN RESCINDED. INFORMATION PREVIOUSLY CONTAINED IN THIS MANUAL IS NOW INCLUDED IN OTHER TECHNICAL MANUALS AS FOLLOWS:

(Was in R-3825-8)	(Now in)
Section I — Description and Leading Particulars	R-3825-5, Volume II, change dated 26 May 1969, Section XXXIII — Components Installer Equipment
Section II — Preparation for Use	R-3825-3, Volume I, dated 6 June 1969, Section V — Preparation of Components Handler Equipment for Use
Section III — Rocket Engine Component Removal and Installation	R-3825-3, Volume I, dated 6 June 1969, Section III — Component Removal and Installation
Section IV — Maintenance	R-3825-5, Volume II, change dated 26 May 1969, Section XXXIII — Component Installer Equipment

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29 JULY 1969

LIST OF EFFECTIVE PAGES

NOTE The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 258 **CONSISTING OF THE FOLLOWING:**

Page No	Issue	Page No	Issue	Page No.	Issue
Title	Original				
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i thru vii	Original				
viii Blank	Original				
1-1 thru 1-20	Original				
2-1 thru 2-60	Original				
3-1 thru 3-122	Original				
4-1 thru 4-43	Original				
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INTRODUCTION TO J-2 ROCKET ENGINE TECHNICAL MANUALS

This manual is one of eight technical manuals and volumes especially prepared to enable the technician to more effectively maintain the J-2 Rocket Engine, Part Number 103826, and related ground support equipment, designed and manufactured by Rocketdyne, a division of North American Rockwell Corporation, 6633 Canoga Avenue, Canoga Park, California 91304. The information provided in these manuals was prepared by Logistics Product Manuals & Training Department of Rocketdyne.

The technical information in these manuals is based upon information available as of the date indicated on the title page of each manual or volume. To keep the information current, the manuals are reviewed continually and changed as required.

Manual Data Supplements are issued occasionally to communicate important and urgent information concerning equipment covered in these manuals. These supplements bear identifying numbers and must be filed in the Appendix to the appropriate manual or volume.

The following chart defines the manual-task-site relationships:

MANUAL	TASK SUPPORT	SITE
J-2 Rocket Engine Data R-3825-1	Provides descriptive, operational, and performance data usable in support of all tasks.	All Sites
J-2 Rocket Engine Operating Instructions R-3825-1B	Provides Stage Contractors with operating data for preparing integrated engine-stage procedures applicable from stage receipt through vehicle launch.	Test and Launch Sites
J-2 Rocket Engine Field Inspection R-3825-2	Provides receiving inspection requirements and leak and function test procedures for engines prior to installation in the stage.	Stage Factory
J-2 Rocket Engine Maintenance and Repair R-3825-3, Volume I	Provides engine handling, component removal and installation, testing, servicing, and in-place tube welding requirements and procedures for noninstalled engines.	All Sites
2 Rocket Engine aintenance and Repair R-3825-3, Volume II	Provides engine component bench test and repair procedures.	All Sites

MANUAL	TASK SUPPORT	SITE
J-2 Rocket Engine Illustrated Parts Breakdown R-3825-4	Lists, describes, and illustrates parts required for maintenance level support of the engine in or out of the stage.	All Sites
J-2 Rocket Engine Ground Support Equipment Maintenance and Repair R-3825-5, Volumes I and II	Provides maintenance and repair data for engine ground support equipment.	All Sites
J-2 Rocket Engine Components Handler Equipment Operation and Maintenance R-3825-8	Provides operation and maintenance instructions for engine components handler equipment and includes related engine component removal and installation procedures.	Stage Factory, and Test and Launch Sites

HOW TO FIND INFORMATION.

A complete listing of all J-2 Rocket Engine Technical Manuals is in this introduction. The table of contents for each manual appears below the manual title. The table of contents at the beginning of each manual lists the section titles. At the head of each section another, more detailed, table of contents lists the key titles of that section only.

In summary, these are the various methods by which the desired information can be found:

- Check the List of J-2 Rocket Engine Technical Manuals in this introduction to locate the manual containing the desired information.
- Look in the table of contents at the front of the manual for the section containing the desired information.
- On the first page of the applicable section, check the detailed table of contents of the section and locate the paragraph and/or page number of the specific material.

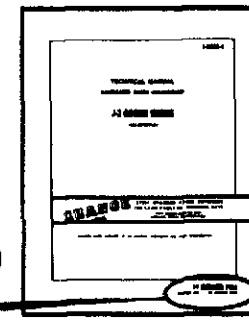
HOW TO KEEP YOUR MANUAL UP-TO-DATE.

As design changes are made to the rocket engine and ground support equipment, and better methods of maintenance are discovered, your manual is periodically changed, revised, or supplemented. The following steps will aid you in maintaining a current manual:

STEP 1. To be sure that yours is the latest issue of the manual, refer to Rocketdyne Report No. R-5788, Saturn J-2 Configuration Identification & Status Report, which is revised monthly and lists the technical manual numbers, titles, supplements, and latest change or revision dates. The date on the title page of your manual should be the same or later than the date in R-5788.

The title page of your manual includes the basic or revised publication date in the lower right-hand corner, with the latest change number and date immediately below.

19 DECEMBER 1966
CHANGE NO. 1 - 17 MARCH 1967

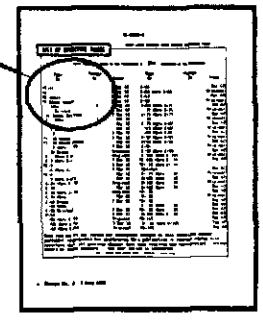


STEP 2. If your manual is not up-to-date, obtain an updated copy through your technical manual supply system.

STEP 3. Insert the changed, revised, or supplement pages as follows:

A. CHANGES. The "A" page of your manual contains a List of Effective Pages which shows what the change status of your manual should be since the last revision or basic issue. All pages, except supplements, are listed, whether they are original, changed, added, or deleted. The dates of changed and added pages, and the dates pages were deleted, are given in the Issue column. The asterisk indicates pages changed, added, or deleted by the current change. Text and illustration changes or additions on the newly changed pages are indicated by a black vertical line in the margin. Compare lines of text and illustrations so marked with the same data on the old page to determine a change in information. Frequently, a greater amount of new information requires that some of the existing information be relocated on a preceding or succeeding page(s).

Page No.	Change No.	Issue
*Title.....	2	...5 May 67
*A	2	...5 May 67
*i thru ii.....	2	...5 May 67
iii Deleted...	1	..17 Mar 67
iv Blank Deleted.....	1	..17 Mar 67
1-1 thru 1-30.		...Original
2-1 thru 2-4..	1	..17 Mar 67
*2-5 thru 2-10 Added.....	2	...5 May 67

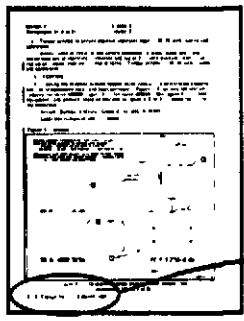


To collate newly changed pages, refer to the newly issued "A" page and proceed as follows:

1. Remove and destroy all deleted pages, including lettered pages located among the grouped page numbers listed as deleted.

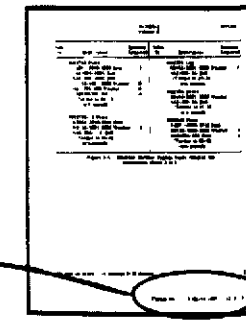
2. Replace all old, like-numbered pages with the newly changed pages.

3. Insert all lettered pages in alphabetical order following the page with the same basic number; for example, pages 3-14A, 3-14B, etc, should follow page 3-14.



Each changed page carries the change number and date on the lower left- or right-hand corner.

Change No. 1 - 2 March 1967



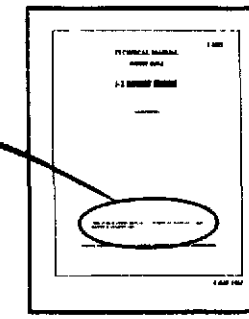
B. REVISION OF SECTION BY CHANGE ACTION. Often, an entire section will be revised and issued in conjunction with changed pages for other sections. A revised section is indicated on the "A" page by the listing of the first and last page numbers of the newly revised section, connected by the word "thru." The change number and date of the current change are included on each page of a revised section. Technical changes are indicated by a black vertical line in the margin. To collate a revised section, refer to the newly issued "A" page and proceed as follows:

1. Remove and destroy the existing pages as a section, including lettered pages located among the existing pages of the section.

2. Insert the revised pages as a section.

C. REVISIONS OF MANUAL. When a replacement notice appears on the new title page, the entire manual has been revised and a complete set of new pages has been issued.

THIS PUBLICATION REPLACES TECHNICAL MANUAL R-3825-1 DATED 6 AUGUST 1965.



To collate a complete revision to your manual, proceed as follows:

1. Remove and destroy all existing pages of your manual except Manual Data Supplements which have not been incorporated.

2. Insert the new pages in your manual cover.

D. SUPPLEMENTS. Supplements are issued to transmit urgent information and are incorporated in subsequent changes or revisions. To insert the supplement, proceed as follows:

1. Make a suitable reference on the pages where the existing data is affected by the supplement.

2. File the supplement in the Appendix to your manual.

LIST OF J-2 ROCKET ENGINE TECHNICAL MANUALS

ENGINE DATA
R-3825-1

I	Description and Operation
II	Thrust Chamber and Gimbal System
III	Gas Generator and Exhaust System
IV	Propellant Feed System
V	Control System
VI	Start System
VII	Instrumentation System
VIII	Performance
IX	Mass Properties and Design Load Criteria
X	Electrical Systems Interface Data
XI	Instrumentation System Interface Data
XII	Customer Connections

ENGINE OPERATING INSTRUCTIONS
R-3825-1B

	General Requirements
II	Pre-Static-Test Requirements and Procedures
III	Static-Test Requirements and Procedures
IV	Static-Test Abort Requirements
V	Post-Static Test Requirements and Procedures
VI	Preparing for Launch
VII	Launch Abort Requirements
VIII	Special Inspections and Procedures
IX	Engine Leak- and Function-Test Procedures

ENGINE FIELD INSPECTION
R-3825-2

I	Preparation for Inspection
II	Receiving Inspection Requirements
III	Leak- and Function-Testing

ENGINE MAINTENANCE AND REPAIR
R-3825-3, Volume I

I	Description and Operation
II	Handling
III	Component Removal and Installation
IV	Post-Maintenance Testing
V	Servicing
VI	In-Place Tube Welding

ENGINE MAINTENANCE AND REPAIR
R-3825-3, Volume II

I	General Repair
II	Thrust Chamber
III	Heat Exchanger
IV	Heat Exchanger Antiflood Check Valve
V	Oxidizer Turbine Bypass Valve
VI	Gas Generator Control Valve
VII	Fuel Turbopump
VIII	Main Oxidizer Valve
IX	Main Fuel Valve
X	Oxidizer Bleed Valve
XI	Fuel Bleed Valve
XII	Augmented Spark Igniter Valve
XIII	High-Pressure Relief Valve
XIV	Four-Way Pneumatic Control Valve
XV	Three-Way Pneumatic Control Valve
XVI	Ignition Detector Probe
XVII	Mainstage OK Pressure Switch
XVIII	Armored Harness
XIX	Integral Hydrogen-Helium Start Tank
XX	Start Tank Support and Fill Valve
XXI	Start Tank Discharge Valve
XXII	Fuel Jacket Purge Check Valve
XXIII	Oxidizer Turbopump
XXIV	Propellant Utilization Valve
XXV	Flight Instrumentation Packages
XXVI	Spark Igniter Cables

ENGINE ILLUSTRATED PARTS BREAKDOWN
R-3825-4

I Introduction
II Group Assembly Parts List
III Numerical Index

GSE MAINTENANCE AND REPAIR
R-3825-5, Volume I

I General Information
II Thrust Chamber Throat Plug Kit G3120
III Thrust Chamber Protective Pad 9016705
IV Electrical Checkout Console G1037
V Flight Instrumentation Checkout Console G1035
VI Data Recorder Console G3121
VII Engine Test Plates, Adapters, and Tools
VIII Extended Range Vibration Safety Cutoff Set G1038
IX Pneumatic Console G3106
X Pneumatic Flow Tester G3104
XI Simulator Panel 9024480-11
XII Components Test Console G3107
XIII Automatic Inert Gas Arc Welding Set G3128
XIV Single Head Special Tool Kit G3127

GSE MAINTENANCE AND REPAIR
R-3825-5, Volume II

I General Information
II Gas Generator High-Low Temperature Cutoff Panel G1047
III Outboard Engine Restrainer G4066
IV Film-Cooled Diffuser G4070
V Components Adapter Set 9016796
VI Liquid Nitrogen Service Unit 2425000
VII Electrical Interface Support 9024460
VIII Spark Monitor/Overspeed Cutoff Panel G1045
IX Component Slings
X Spark Monitor Turbine Overspeed Cutoff Test Set 9024499
XI Ignition Detector Set 99-9026355
XII Components Maintenance Sets/Kits
XIII Vibration Safety Cutoff Test Set 9024498
XIV Hot-Gas Temperature Transducers NA5-27323T4 and NA5-27342T3
XV Amplifier Mounting Panel 9024500
XVI Thrust Chamber Diffuser Installing Tool Kit 9025144
XVII Proof-Test Weights
XVIII Engine Handling Slings
XIX Turbopump Slings
XX Propellant Inlet Duct Null Adjuster Set 9024540
XXI Inlet Duct Support Frame Installing Tool Kit 9025150
XXII Engine Handler G4064
XXIII Engine Vertical Installer G4035
XXIV Turbopump Maintenance Stands
XXV Turbopump Maintenance Sets
XXVI Sequence Controller and Oxidizer Heat Exchangers Handlers
XXVII Propellant Inlet Duct Handlers
XXVIII Propellant Feed System Handlers
XXIX Start Tank Installer 9016783
XXX Fluid Lines Interface Support 9020628 and Fluid Lines Interface Arm Support 9026988
XXXI Thrust Chamber Seal Balloon 9016720
XXXII Spark Igniter Cable Pressurization Tool Kit 9025425

COMPONENTS HANDLER EQUIPMENT OPERATION AND MAINTENANCE
R-3825-8

I Description and Leading Particulars
II Preparation for Use
III Rocket Engine Component Removal and Installation
IV Maintenance

SECTION I

DESCRIPTION AND LEADING PARTICULARS

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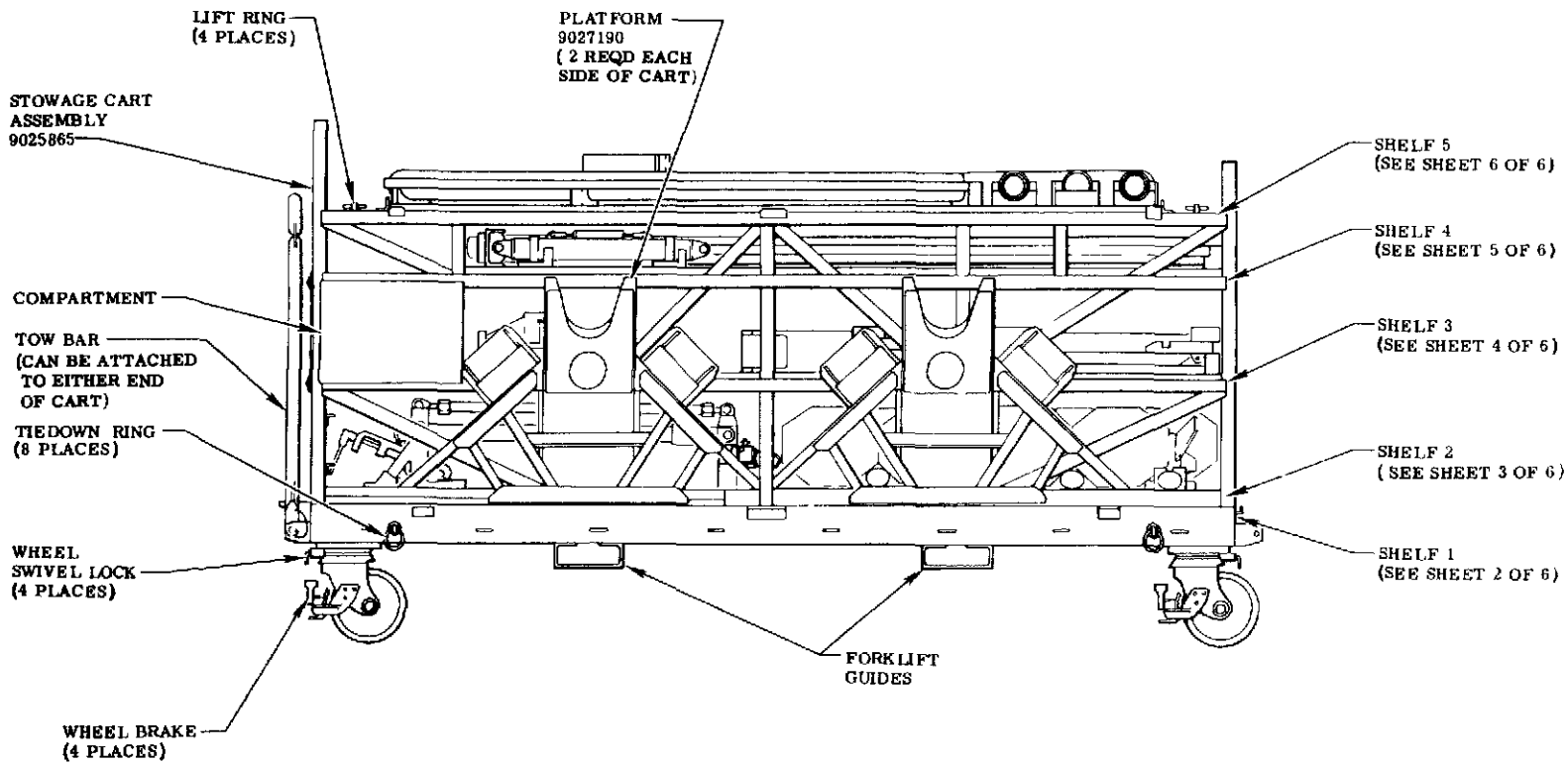
PARAGRAPH	PAGE	PARAGRAPH	PAGE
1-1 Description	1-1	1-8 Access Work Platform	1-18
1-3 Stowage Cart	1-1		
1-4 Track	1-17	1-9 Leading Particulars	1-19
1-5 Hoist	1-17	1-11 Configuration Changes-- Manual Effectivity	1-20
1-6 Engine Lowering Systems	1-17		
1-7 Internal Access Platform	1-18		

1-1. DESCRIPTION.

1-2. Engine Components Installers G4071 (figure 1-1) and G4072 (figure 1-2) provide the capability of safely handling specific engine components during their removal and installation in SII and SIVB stages of a Saturn vehicle with the stages vertical and stacked. Engine Components Installer G4071 is for use within the SII stage and Engine Components Installer G4072, within the SIVB stage. Engine components installer sets 9026251 and 9026252 (figure 1-3), used in conjunction with installers G4071 and G4072, respectively, provide the capability of safely handling the removed engine component when transferring the component from or to the stage. The method of handling engine components is the same for the installer or installer sets. Engine component, through the use of appropriate component handlers, are supported by a mobile hoist. The hoist rides a two-rail track that can be assembled into various configurations, enabling access of the hoist to the component to be removed. The installers and installer sets are complete in that they contain (with the exception of the handtools required for assembly) a hoist, adapters for adapting the hoist to component handlers, track and the equipment necessary to assemble and support the track for any one configuration, work platforms for access, engine lowering systems, and component handlers. Component handlers supplied with the installers supplement existing J-2 engine component handlers to provide a handler for each of the components listed in figure 1-4. Paragraphs 1-3 through 1-8 describe some of the more significant parts of the installers and installer sets.

1-3. STOWAGE CART. Each stowage cart (one for G4071 and one for G4072) provides storage space for all the component parts of its respective component installer. The stowage cart is a welded steel frame with five storage shelves. For identifying the storage location of individual parts, part numbers are stenciled either on the shelves or frames adjacent to the area. Form-fitted wooden blocks, straps, clamps, and/or quick-disconnect pins secure the parts against movement during transportation. For surface travel, the cart is provided with wheels (4) and a tow bar. The wheels are full swiveling and each is equipped with a brake and a swivel lock. The tow bar can be attached to either end of the cart. Forklift guides and four lift rings provide for vertical lifting of the cart. Eight tiedown rings are provided to secure the cart during shipping. A cover that encloses the cart and is secured around the lower perimeter protects the installer from weather.



NOTE
COVER REMOVED FOR CLARITY

• QUANTITIES ARE GIVEN IF MORE THAN ONE IS REQUIRED

J2-8-68

Figure 1-1. Engine Components Installer G4071 (Sheet 1 of 6)

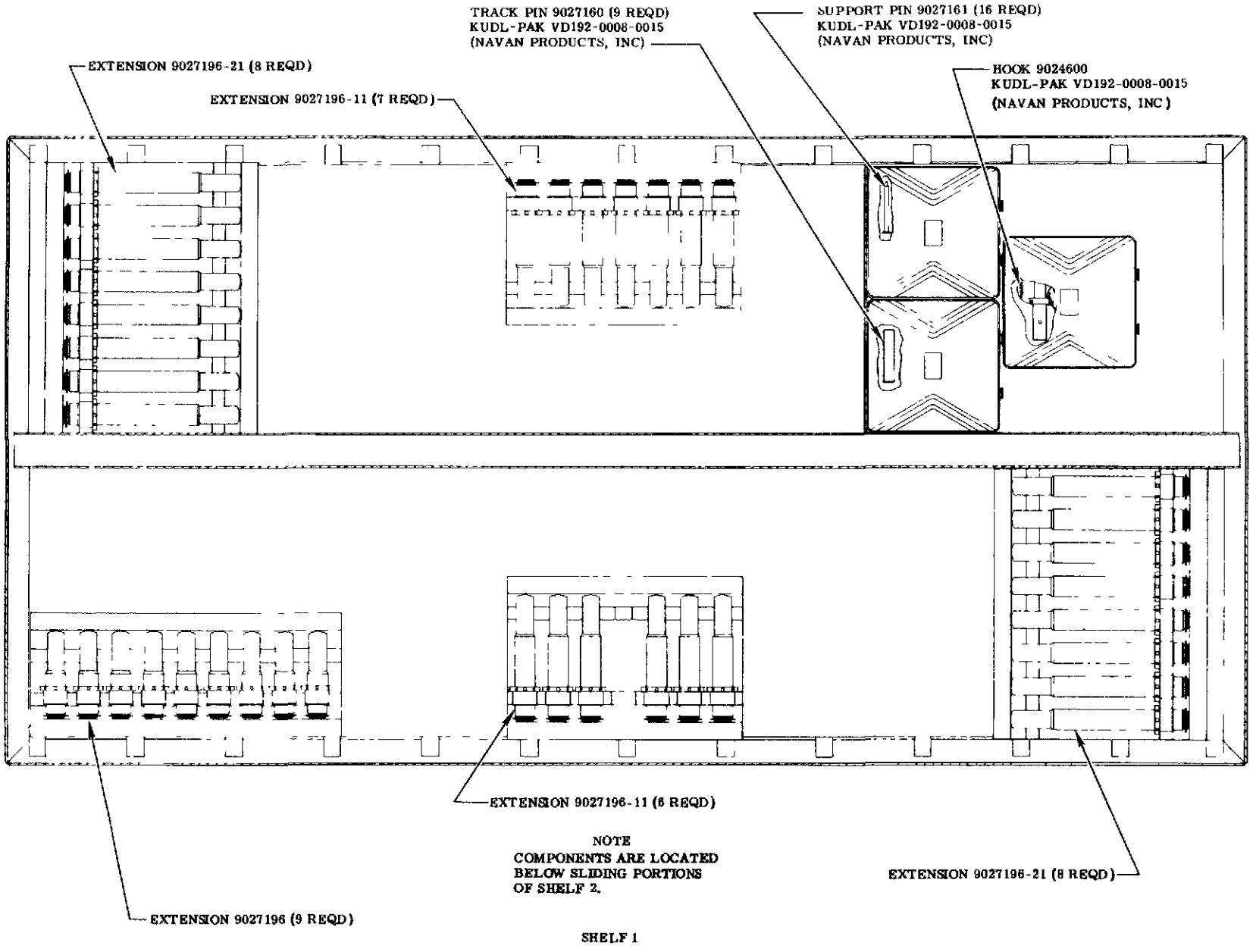


Figure 1-1. Engine Components Installer G4071 (Sheet 2 of 6)

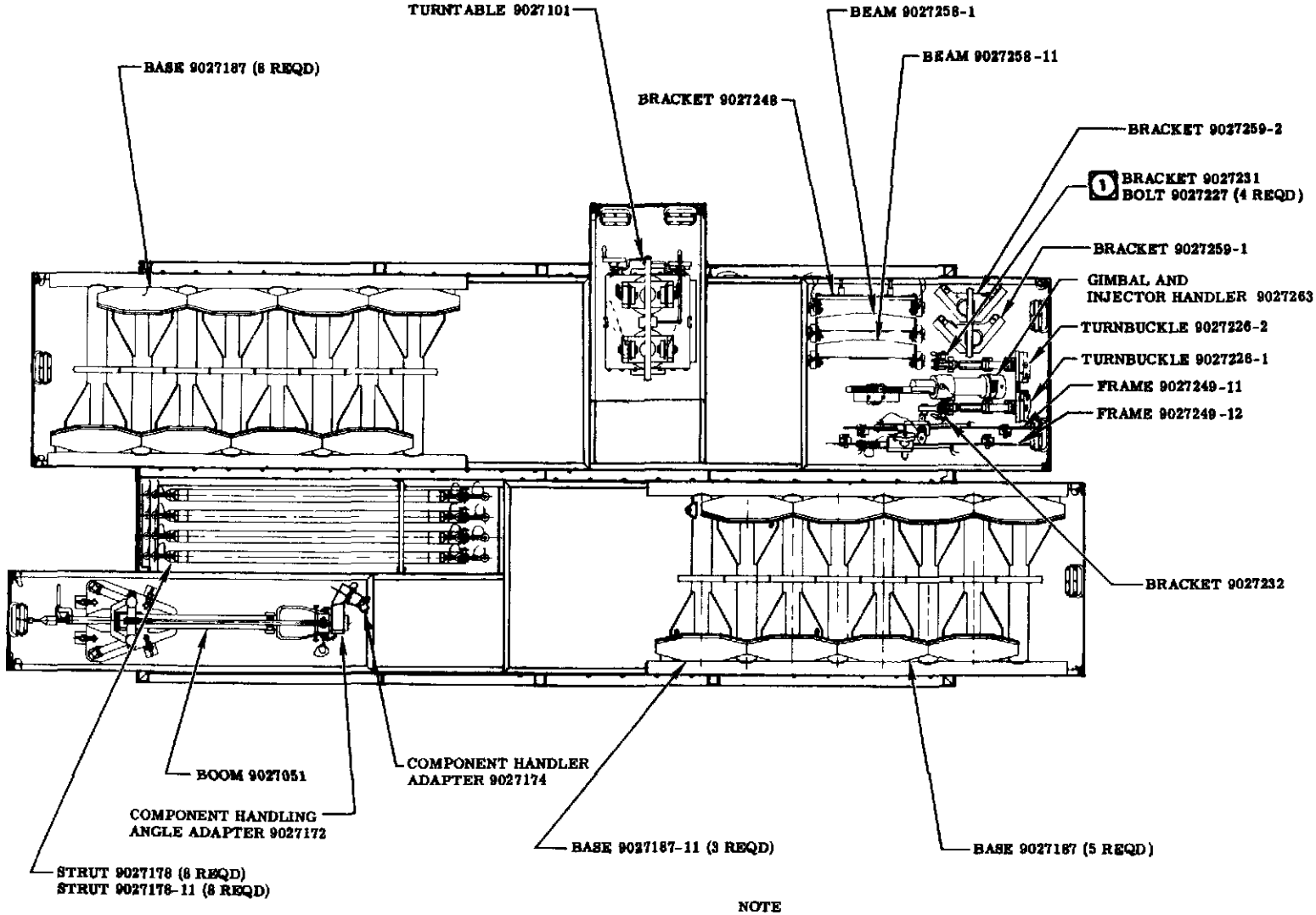


Figure 1-1. Engine Components Installer G4071 (Sheet 3 of 6)

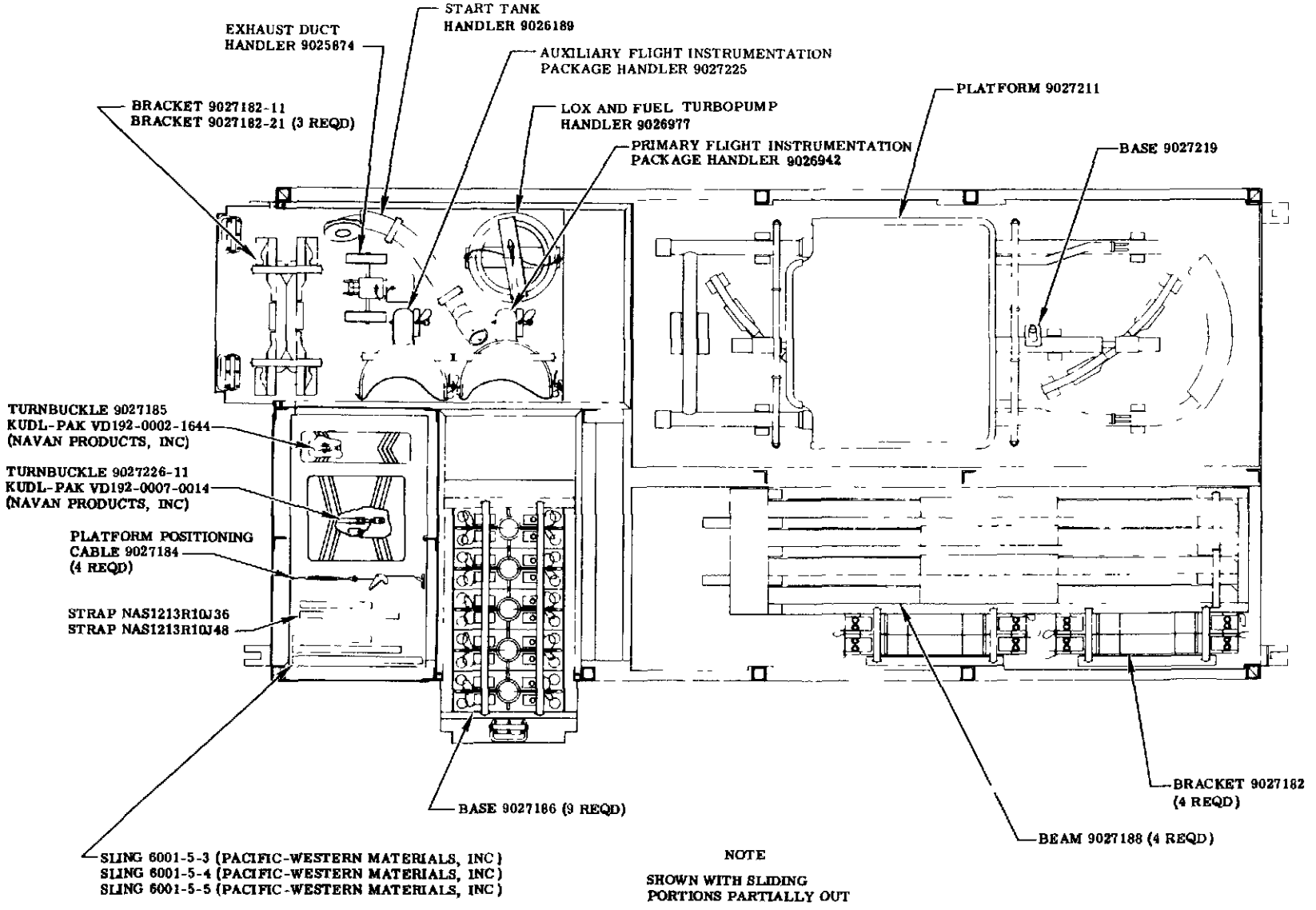


Figure 1-1. Engine Components Installer G4071 (Sheet 4 of 6)

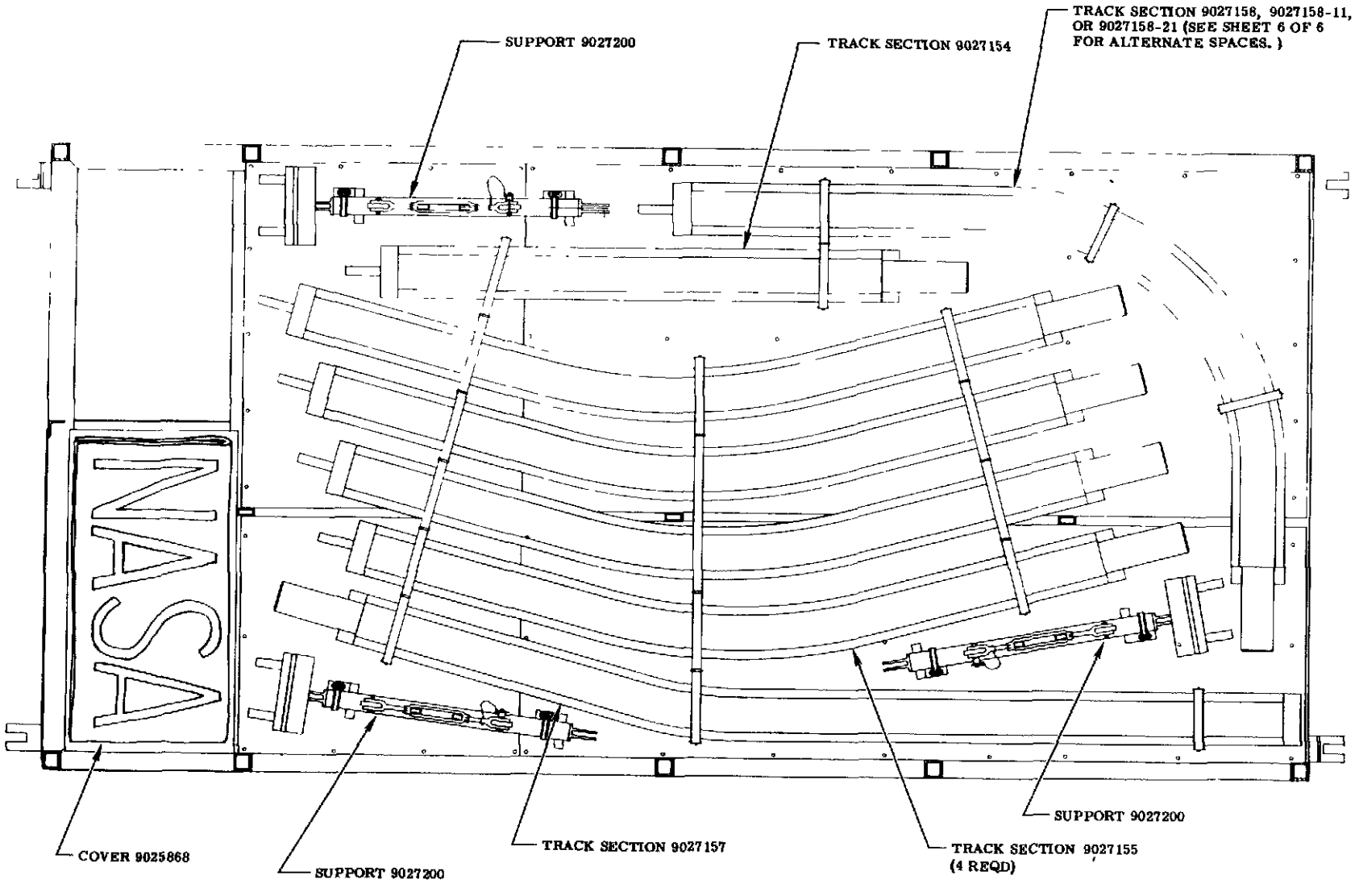


Figure 1-1. Engine Components Installer G4071 (Sheet 5 of 6)

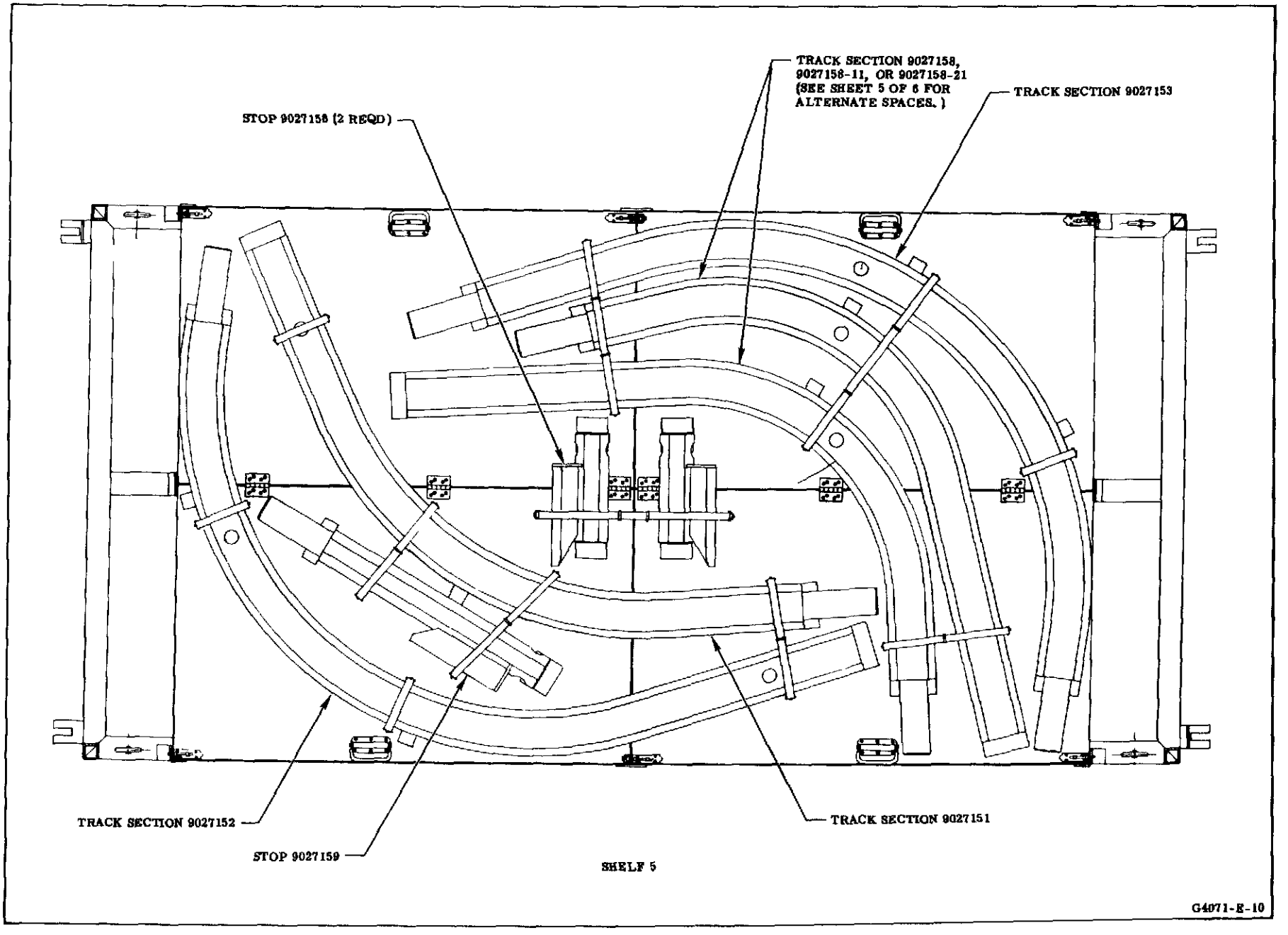

TRACK SECTION 9027158, 9027158-11, OR 9027158-21 (SEE SHEET 5 OF 6 FOR ALTERNATE SPACES.)
TRACK SECTION 9027153
STOP 9027158 (2 REQD)
TRACK SECTION 9027152
STOP 9027159
TRACK SECTION 9027151
SHELF 5
G4071-E-10

Figure 1-1. Engine Components Installer G4071 (Sheet 6 of 6)

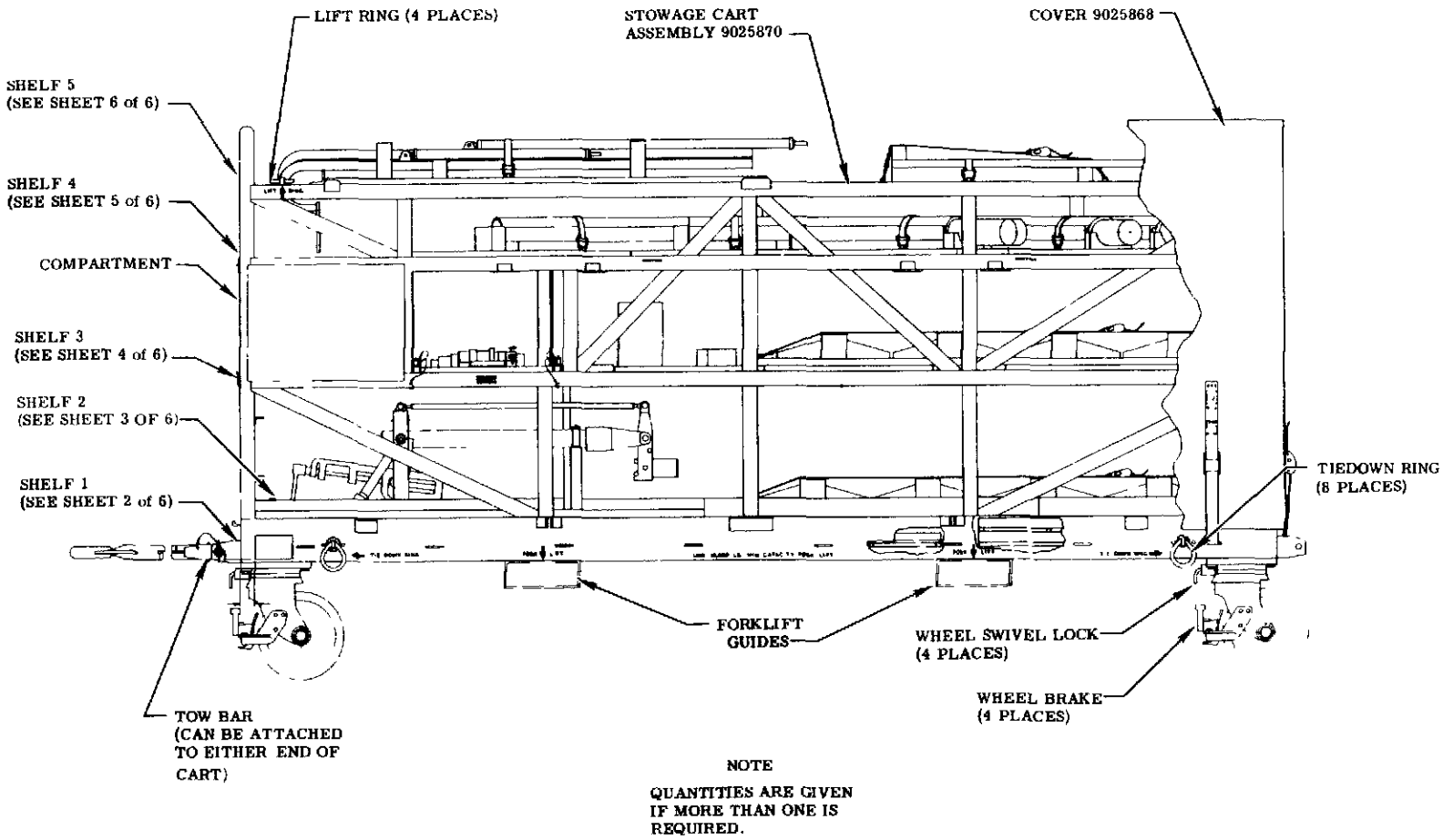

LIFT RING (4 PLACES)
STOWAGE CART ASSEMBLY 9025870
COVER 9025868
SHELF 5 (SEE SHEET 6 of 6)
SHELF 4 (SEE SHEET 5 of 6)
COMPARTMENT
SHELF 3 (SEE SHEET 4 of 6)
SHELF 2 (SEE SHEET 3 OF 6)
SHELF 1 (SEE SHEET 2 of 6)
TIEDOWN RING (8 PLACES)
FORKLIFT GUIDES
WHEEL SWIVEL LOCK (4 PLACES)
WHEEL BRAKE (4 PLACES)
TOW BAR (CAN BE ATTACHED TO EITHER END OF CART)
NOTE
QUANTITIES ARE GIVEN IF MORE THAN ONE IS REQUIRED.
J2-8-27

Figure 1-2. Engine Components Installer G4072 (Sheet 1 of 6)

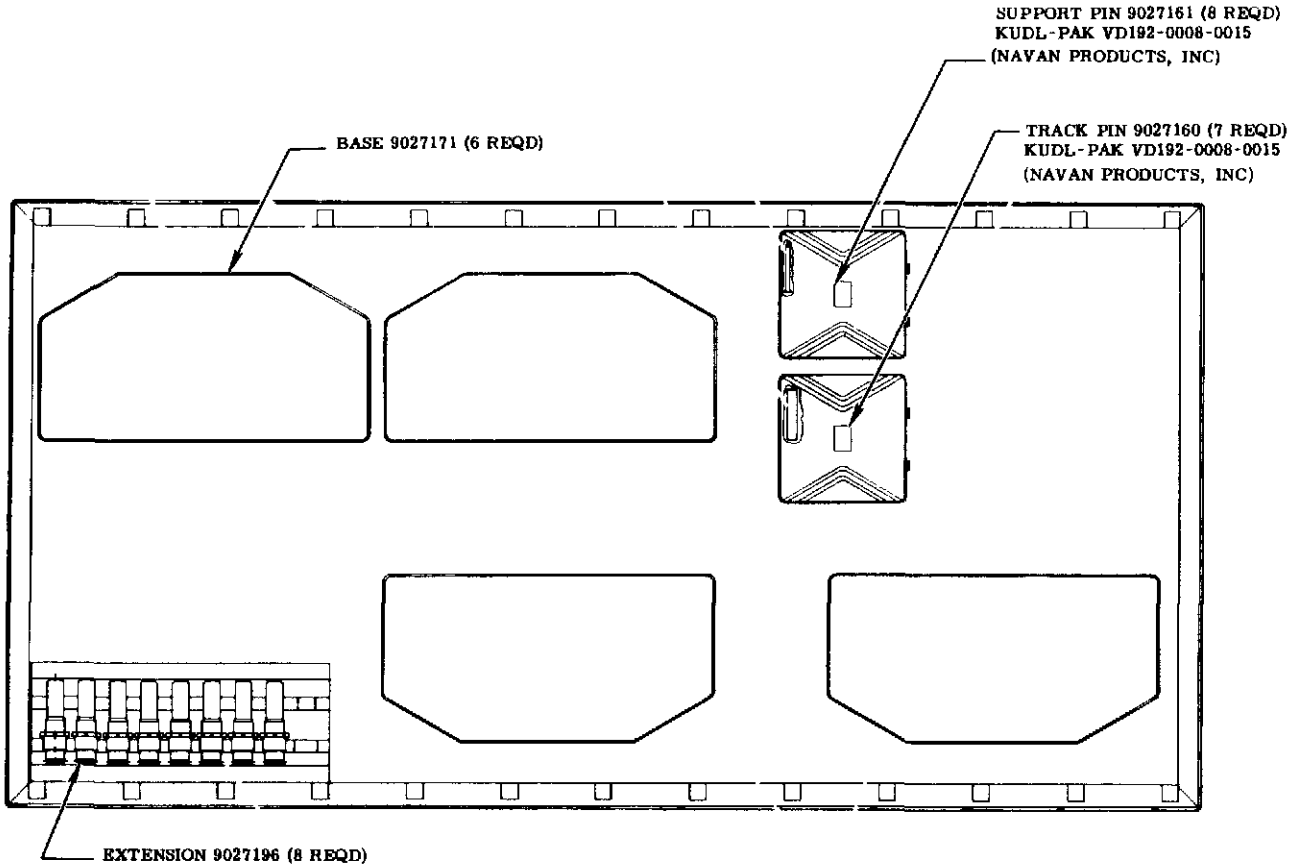
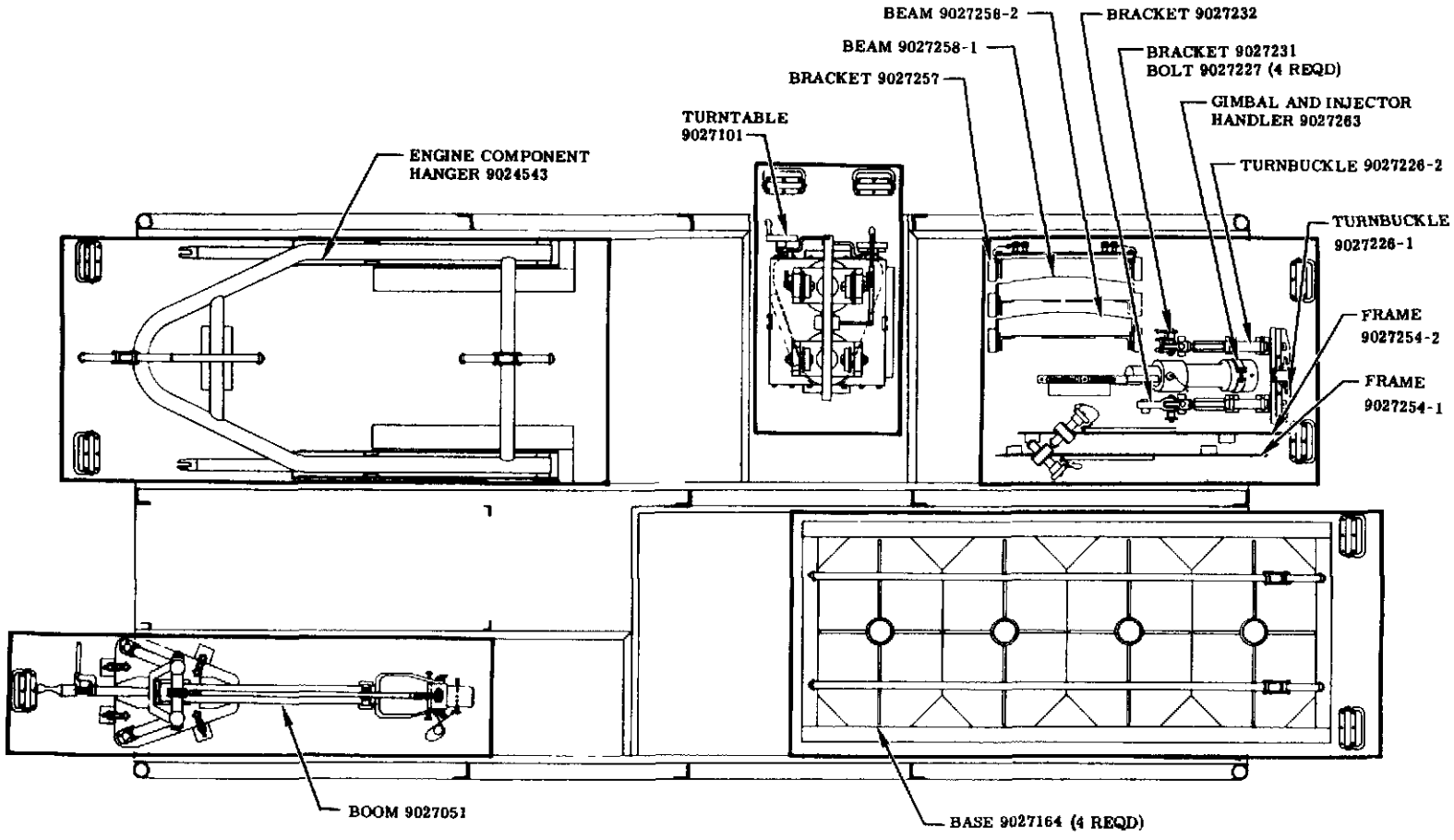


Figure 1-2. Engine Components Installer G4072 (Sheet 2 of 6)



NOTE

SHOWN WITH SLIDING
PORTIONS PARTIALLY OUT

SHELF 2

J2-8-26

Figure 1-2. Engine Components Installer G4072 (Sheet 3 of 6)

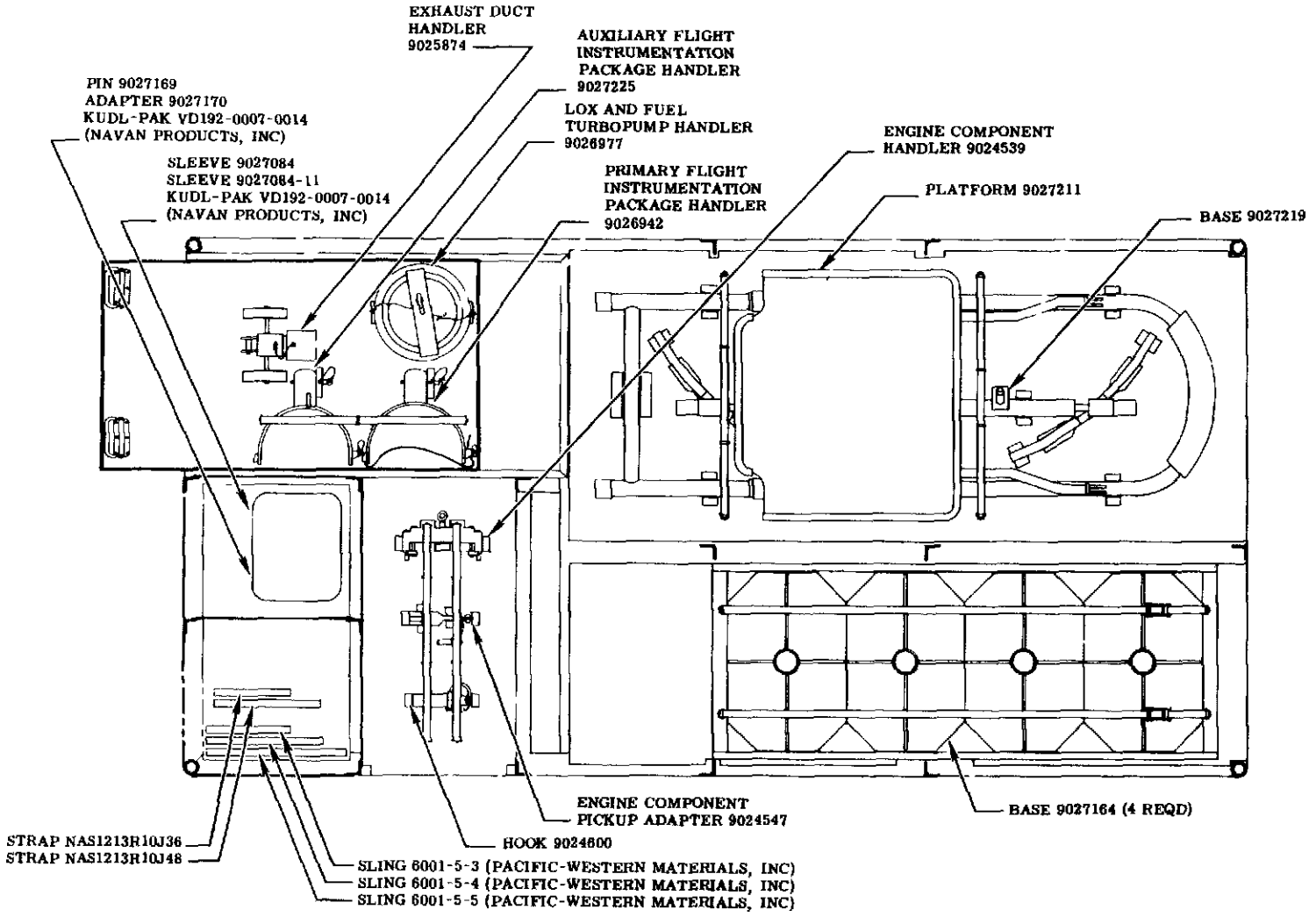


Figure 1-2. Engine Components Installer G4072 (Sheet 4 of 6)

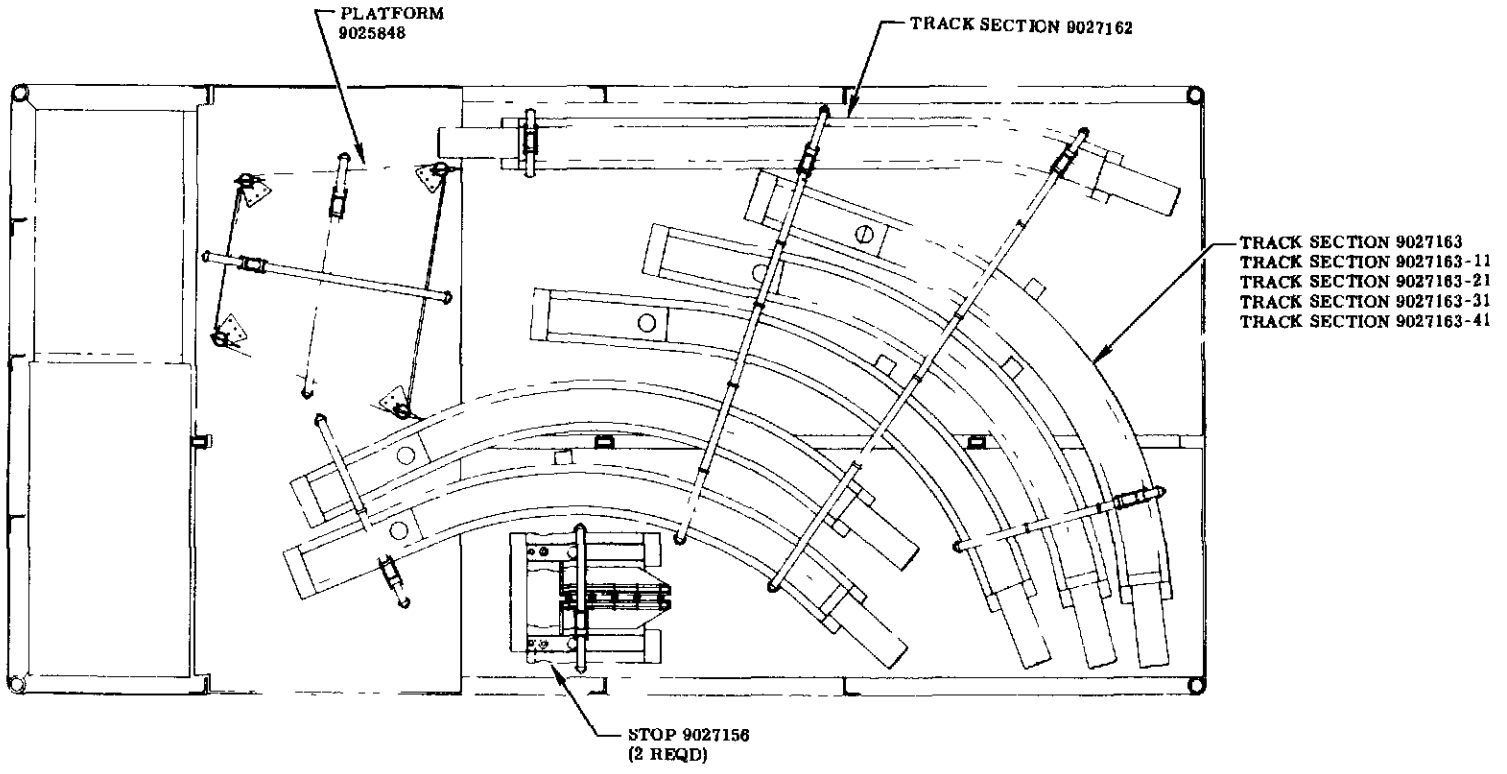
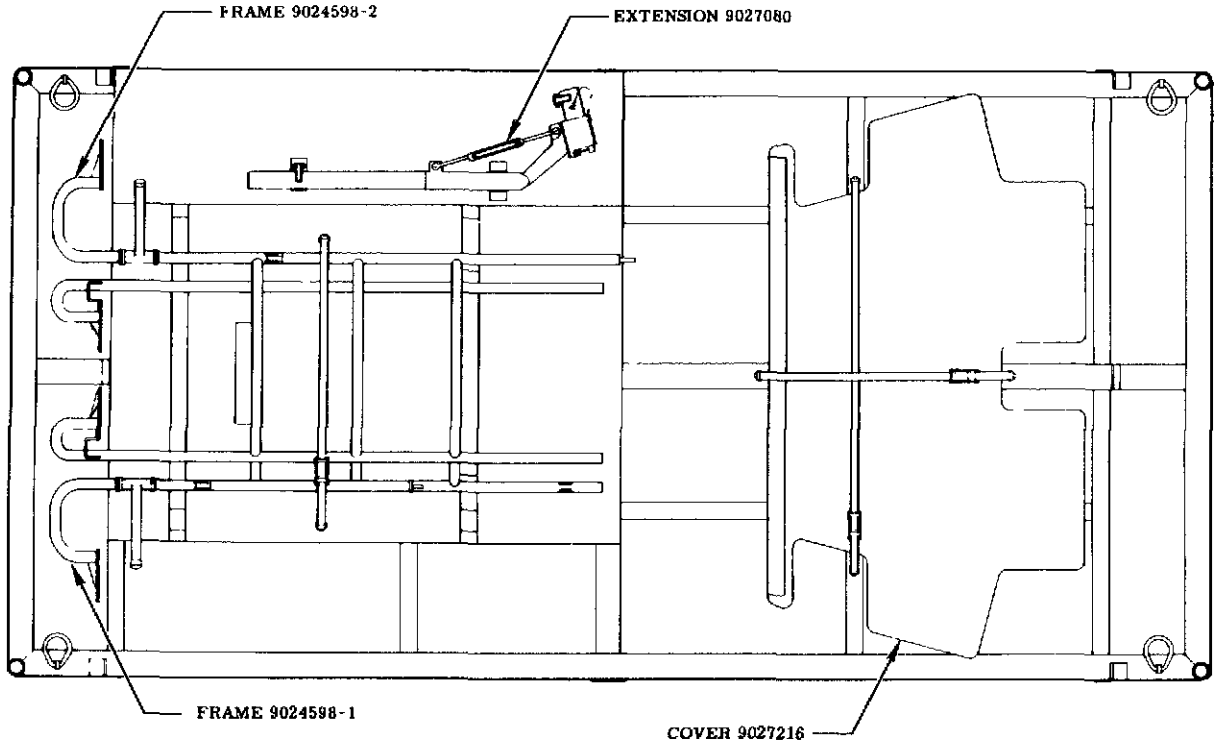


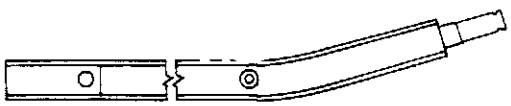
Figure 1-2. Engine Components Installer G4072 (Sheet 5 of 6)



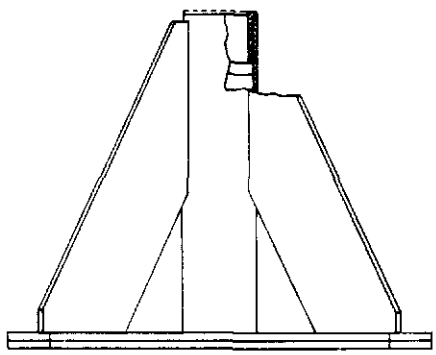
SHELF 5

J2-8-28

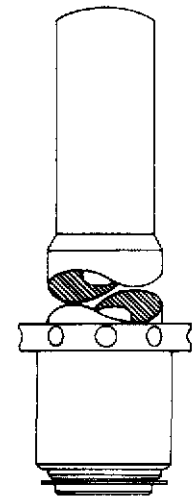
Figure 1-2. Engine Components Installer G4072 (Sheet 6 of 6)



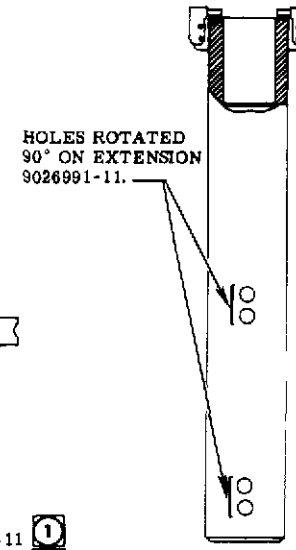
TRACK 9026260 (1)
TRACK 9026260-11 (1)



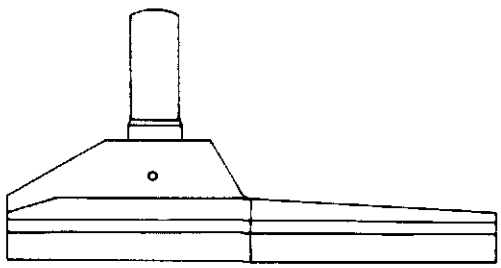
BASE 9026259 (1)



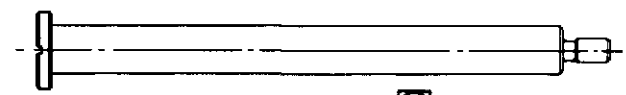
EXTENSION 9027196-11 (1)
EXTENSION 9027196-31 (2)



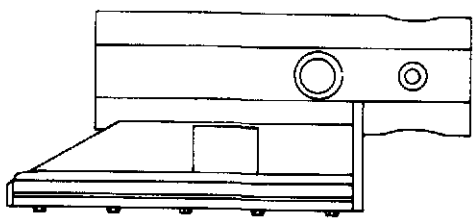
EXTENSION 9026991 (2)
EXTENSION 9026991-11 (2)



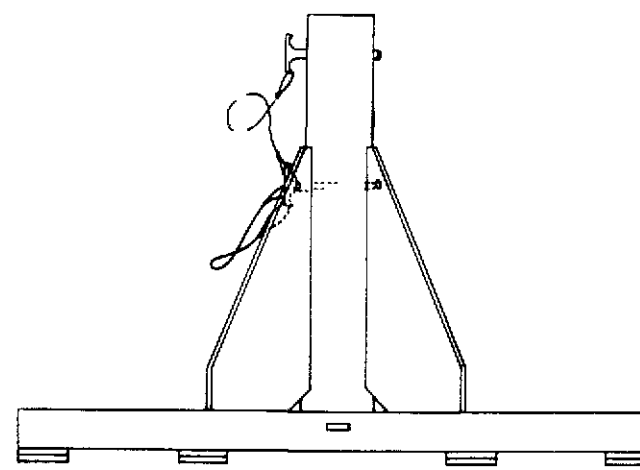
SUPPORT 9026993 (2)



SUPPORT PIN 9027161 (2)



STOP 9027156 (2)



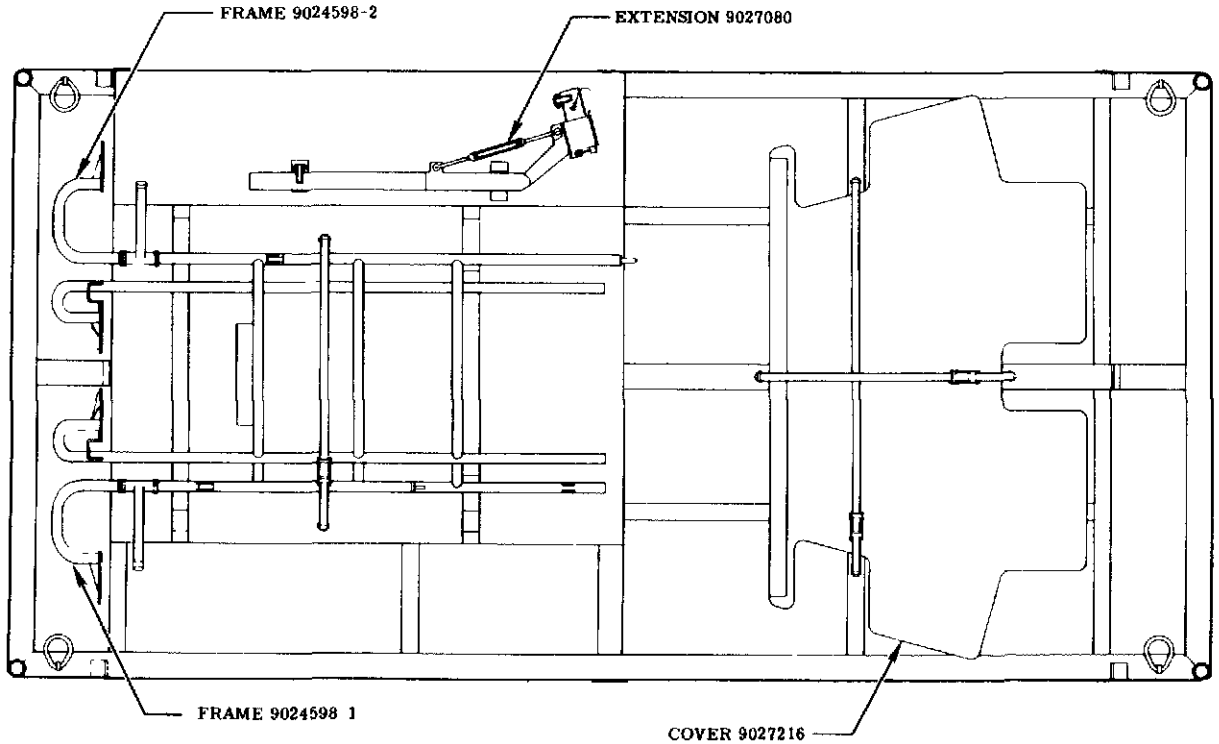
BASE 9026990 (2 REQD) (2)

NOT TO SCALE

(1) IN COMPONENTS INSTALLER SET 9026251
(2) IN COMPONENTS INSTALLER SET 9026252

J2-8-34

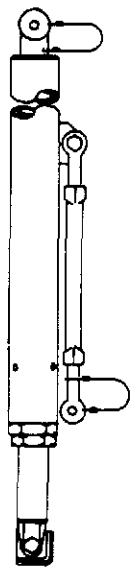
Figure 1-3. Engine Component Installer Sets 9026251 and 9026252 (Sheet 1 of 3)



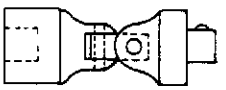
SHELF 5

J2-8-28

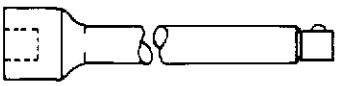
Figure 1-2. Engine Components Installer G4072 (Sheet 6 of 6)



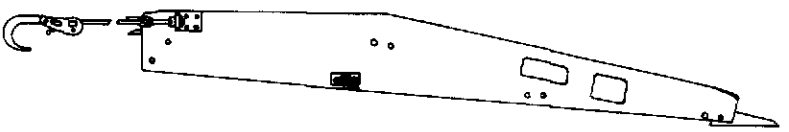
STRUT 9026270 [1]



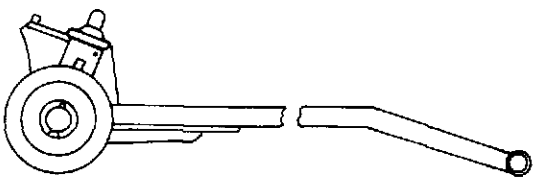
UNIVERSAL JOINT S8 (SNAP-ON TOOLS CORP)



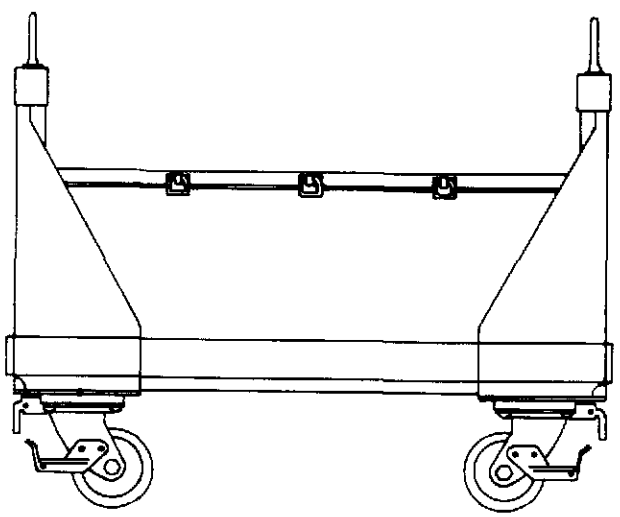
EXTENSION BAR SX24 (SNAP-ON TOOLS CORP)



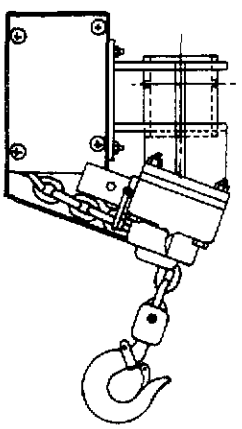
RAMP 9026255 (3 REQD)



LIFT JACK RNS-LJ-6P (HAMILTON CASTER & MFG CO)



COMPONENT HANDLING CART 9026253

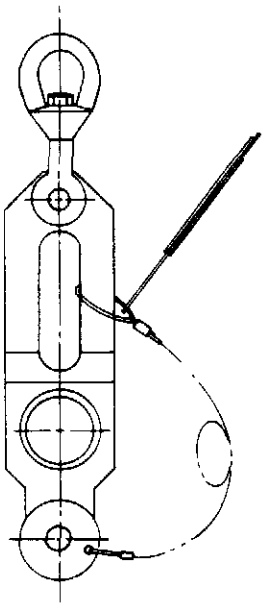


HOIST 9027095

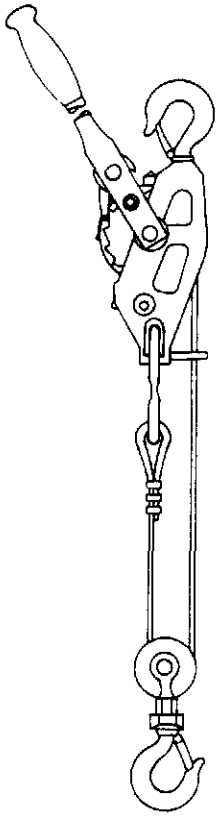
[1] IN COMPONENTS INSTALLER SET 9026251

J2-8-35

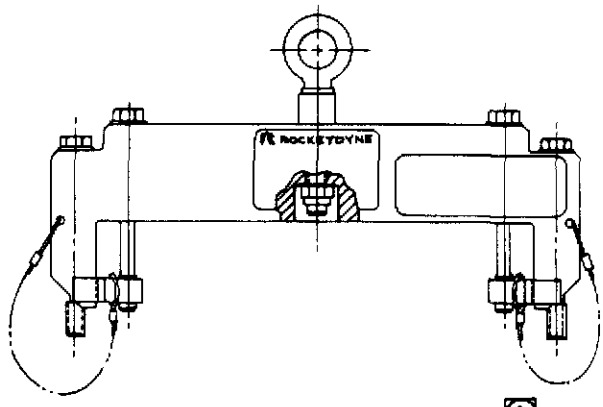
Figure 1-3. Engine Component Installer Sets 9026251 and 9026252 (Sheet 2 of 3)



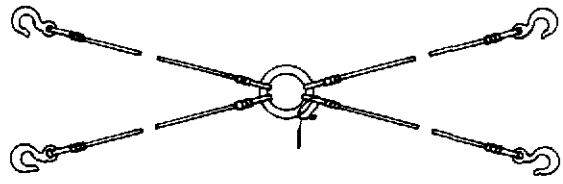
ENGINE COMPONENT
PICKUP ADAPTER 9024547 (1)



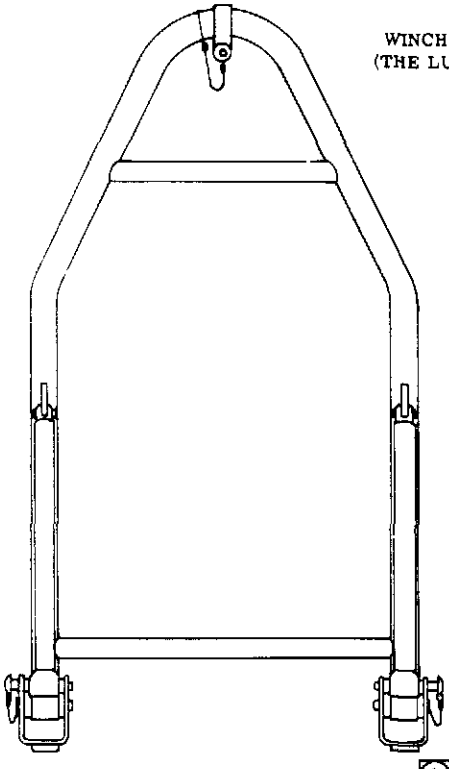
WINCH-HOIST 2250-38M-3S
(THE LUG-ALL CO) (2 REQD)



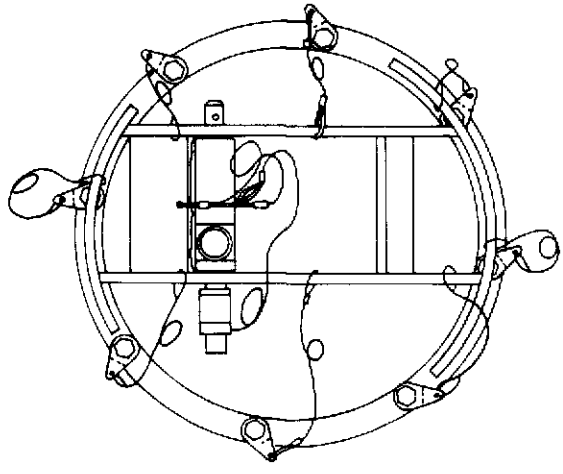
ENGINE COMPONENT HANDLER 9024539 (1)



CABLE 9026256



ENGINE COMPONENT HANGER 9024543 (1)



LOX AND FUEL TURBOPUMP HANDLER 9026997 (2)

SLING 6001-5-25
(PACIFIC-WESTERN
MATERIALS INC) (2 REQD)

(1) IN COMPONENTS INSTALLER SET 9026251

(2) IN COMPONENTS INSTALLER SET 9026252

J2-8-36

Figure 1-3. Engine Component Installer Sets 9026251 and 9026252 (Sheet 3 of 3)

Component	Nominal Weight (Pounds)
Auxiliary flight instrumentation package[a]	29
Electrical control assembly	58
Fuel high-pressure duct	74
Fuel inlet duct	111[b]
Fuel turbopump	418
Gimbal	77
Heat exchanger	104
Integral hydrogen-helium start tank	89
Oxidizer high-pressure duct	64
Oxidizer inlet duct	94[c]
Oxidizer turbopump	304
Primary flight instrumentation package[a]	32
Thrust chamber injector	290[d]
Turbine exhaust duct	73

(a) Use of engine components installers to remove these components is optional.
(b) 136 pounds if Haynes 25 (L605) bellows is used
(c) 121 pounds if Haynes 25 (L605) bellows is used
(d) Combined weight of injector and gimbal

Figure 1-4. Components Handled with Engine Components Installers and Installer Sets

1-4. TRACK. The track supports and provides directional control for the hoist. Tracks are short sections of heavy-walled tube with rails, which provide rolling surfaces for the upper and lower wheels of the hoist, fastened to each side. The sections of track can be mated to form various configured track assemblies. To provide the ease of handling necessary in the stage environment, the track is made in short, manageable sections. Pedestal-type supports and threaded extensions support the track and provide adjustment for leveling. The supports rest on existing stage work platforms. For the SII stage, where work platforms are not available around the center engine, Engine Components Installer G4071 contains platforms, beams, struts and brackets for assembly of a support base for the track. The support hose is suspended from the stage thrust structure and surrounds the center engine. Track stops for each end of the assembled track bring the hoist to a gradual stop and prevent the hoist from rolling off the end of the track. Numerical markings on the tracks aid in proper positioning of the hoist for component removal.

1-5. HOIST. The hoist (figure 1-5) supports the weight of the component and provides the flexibility required to manipulate the component for removal or installation in the congested engine and stage environment. This flexibility is attained through controls that rotate, raise, lower, and laterally move (perpendicular to the track) the hoist boom. Scales are provided on the hoist as references for determining the amount of movement and for duplicating hoist attitudes. In addition, limited adjustment around all three axes of the boom adapter provides the precise alinement required to engage component handlers or to engage component handlers to engine components. The hoist uses a dual-wheel arrangement that straddles (one set above and one below) the track rails, engaging the hoist with the track under all load conditions. Two of the wheels can be rotated by hand through a chain drive and are used for precise movement of the hoist along the track. The hoist has a spring-loaded friction shoe that contacts the top surface of the track, acting as a brake. A manually operated lever disengages the brake.

1-6. ENGINE LOWERING SYSTEMS. The lowering system lowers the engine for removal of the thrust chamber injector and/or gimbal. The system consists of frames, beams, and brackets for attachment to the stage structure; brackets for attachment to the engine GSE mounting pads; and turnbuckles for interconnecting the two. When the system is used, the engine is suspended on the turnbuckles and raised and lowered by changing the turnbuckle lengths. Extension of the turnbuckle is limited by roll pins in the turnbuckle threads, which act as stops. Adjustments built into the turnbuckles provide the capability of positioning the turnbuckles vertically and limited engine rotation to aline the gimbal to the stage thrust pad. The system uses the stage-actuator attach points and the oxidizer inlet duct support structure for support of all engines except the center engine of the SII stage. For this engine, the lowering system is supported on the lower beam caps at the juncture of the two stage thrust beams adjacent to each propellant inlet duct.

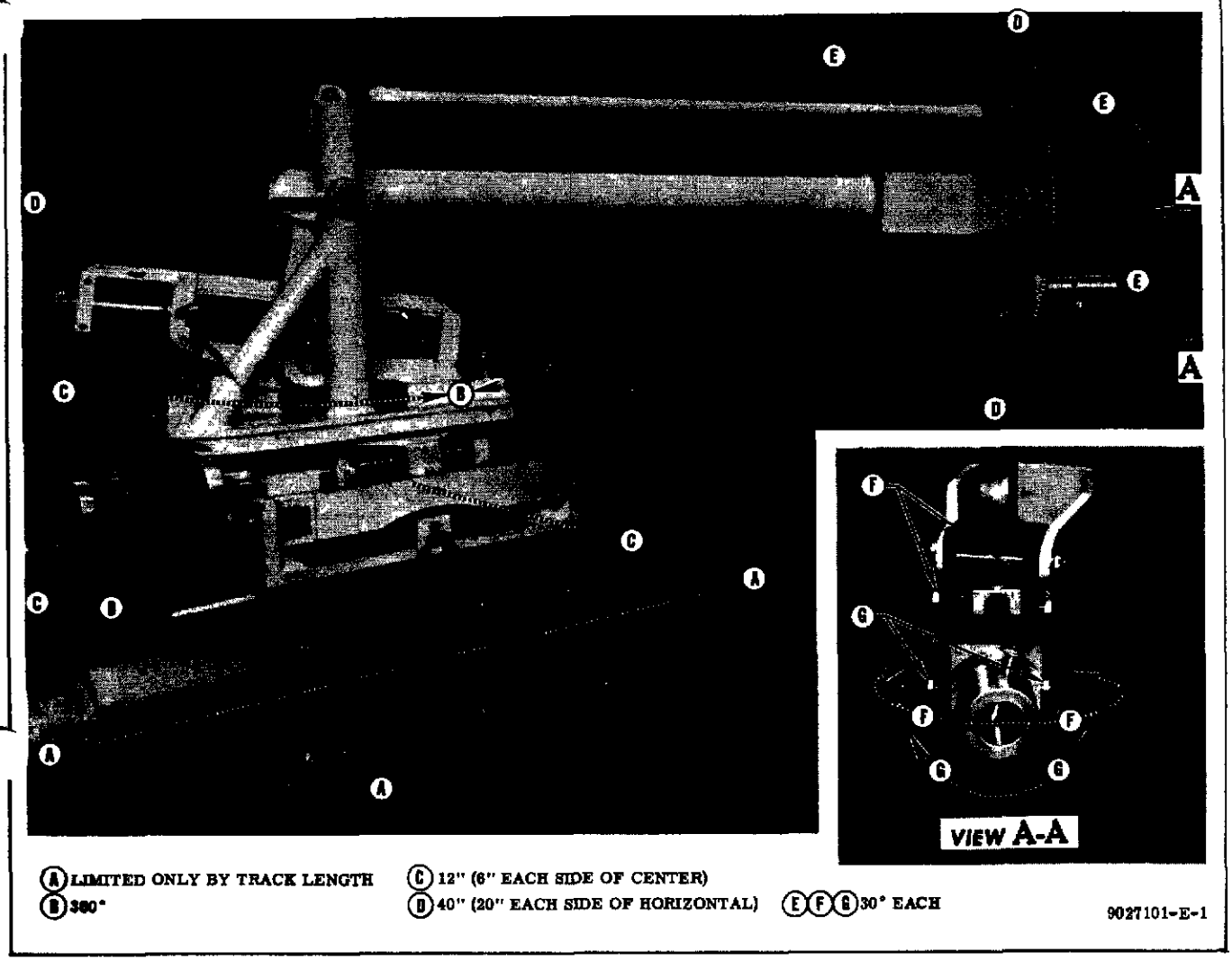


Figure 1-5. Hoist Controls and Ranges

1-7. INTERNAL ACCESS PLATFORM. The internal access platform allows a technician to stand inside the thrust chamber for installation of the thrust chamber throat plug. The platform consists of a base and a folding platform, both made of welded tubular aluminum. The base is attached to the thrust chamber exit flange and supports the platform. The platform is folded for installation into and removal from the chamber. When installed and unfolded, the platform provides a level surface for standing. A step provides access to the platform. The platform has a maximum working load of 250 pounds, sufficient for one man and the throat plug.

1-8. ACCESS WORK PLATFORM. The access work platform (found only on Engine Components Installer G4072) enables access to engine components that are below the level of the SIVB-stage work deck. Installation of the platform requires removing two of the pie-shaped stage work-deck sections. The platform is inserted into the opening provided by removal of the sections and secured to the stage work deck. On 500-series stages, the platform is used in conjunction with a cover, which covers the larger opening created by the removal of the two sections on this stage. The platform is manufactured of tubular and plate aluminum. The

cover is manufactured of tubular aluminum and wood. Three parts, a left- and right-hand frame and a base, make up the platform. Ease of assembly and disassembly is provided by use of quick-disconnect ball-lock pins (6). The installed platform provides a work surface for one man 5 feet below the stage work deck.

1-9. LEADING PARTICULARS.

1-10. See figure 1-6 for leading particulars of significant components of Engine Components Installers G4071 and G4072. See figure 1-7 for leading particulars of significant components of engine components installer sets 9026251 and 9026252.

Components Installers	G4071	G4072
Weight	9,000 lb	7,200 lb
Stowage cart		
Weight	To be determined	(a)
Height	6 ft 4 in.	(a)
Width	6 ft	(a)
Length	12 ft	(a)
Mobility		
Surface travel	Four full-swivel casters equipped with swivel locks and brakes. Tow bar capable of being attached to either end.	(a)
Hoist		
Capacity (maximum)	600 lb or 23,000 in-lb	(a)
Controls	See figure 1-5.	(a)
Turntable		
Weight	133 lb	(a)
Height	15.5 in.	(a)
Width	15.5 in.	(a)
Length	16 in.	(a)
Boom		
Weight	102 lb	(a)
Height	15 in.	(a)
Width	14 in.	(a)
Length	53 in.	(a)
Track sections		
Weight	Range from 45 to 94 lb	55 and 57 lb
Height (cross section)	4.5 in.	(a)
Width (cross section)	6 in.	(a)
Length	Range from 65 to 150.5 in.	93.5 and 79 in.

(a) Same as G4071

Figure 1-6. Leading Particulars--Engine Components Installers G4071 and G4072

mponents aller Sets	9026251	9026252
Component handler cart		
Weight	To be determined	(a)
Height	34 in.	(a)
Width	34 in.	(a)
Length	44 in.	(a)
Mobility		
Surface travel	Four full-swivel casters equipped with swivel locks and brakes. Lift jack capable of being attached to one end.	(a)
Capacity	560 lb	(a)
Towing speed	Manual	(a)
Vertical lifting	Lift rings (4) for sling (9026256)	(a)
Winch-hoist		
Capacity (working)	800 lb (double cable)	
Lifting distance	38 ft (single cable) 19 ft (double cable)	
Chain hoist		
Capacity (working)	560 lb	(a)
Lifting distance	25 ft	(a)

(a) Same as 9026251

Figure 1-7. Leading Particulars--Engine Components Installer Sets 9026251 and 9026252

1-11. CONFIGURATION CHANGES--MANUAL EFFECTIVITY.

1-12. Modifications of the components installer are listed in figure 1-8.

Approved ECP No.	MD No.	Incorporated in Manual Dated
J2-611	1	21 March 1968

Figure 1-8. Configuration Changes--Manual Effectivity

SECTION II

PREPARATION FOR USE

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2-1. SCOPE. This section provides procedures for preparing for use Engine Components Installers G4071 and G4072 and Engine Components Installer Sets 9026251 and 9026252. This section does not provide the capability of determining which of the included procedures are required for an individual component removal and/or installation. This information is found in the component removal and installation section (section III). Therefore, to effectively utilize the information in this section, users need perform only those procedures required by the applicable component removal and/or installation procedures found in section III.

2-2. GENERAL INFORMATION.

2-3. Preparing the installers and installer sets for use involves selecting, transporting into the stage, and assembling the installer parts into a configuration designed to accomplish the required task. Assembling the installer parts within the stage requires careful manipulation if injury to personnel and damage to stage or equipment are to be avoided. Cautions and warnings are given wherever a potentially hazardous condition is known to exist. Adequate precautionary data is provided for hazards that are the result of the characteristics of the

mponents installer. No claim is made of nilar coverage for hazards caused by stage configuration or limitations. Where cognizance of such stage hazards has been obtained, cautions and warnings are incorporated in the affected procedure. An example of this differentiation is the included precaution against overloading SII-stage heat shields, whereas limitations of the stage work platform, since not obtained, are not noted. To make sure that all safety precautions are taken, personnel performing these tasks must be made aware of all stage safety requirements. The lateral loading of the components installer, when installed, is limited to 0.25g maximum load; consequently, this equipment must be used with the stage vertical and stationary.

2-4. LOADING AND UNLOADING G4071 AND G4072 STOWAGE CARTS.

2-5. The stowage cart contains all parts of the installers. Since individual tasks do not require use of all parts, knowledge of the task to be performed is essential if unnecessary unloading of the cart is to be avoided. To aid in preventing unnecessary unloading, each of the assembly ıks found in this section contains a figure .ıting the parts of the installer that are required and the shelf on which the part is stored. When the task involves a large number of parts, the figure recommends an area within the stage for temporary placement prior to the assembly procedure. Hinges, slide-bolts, and handles permit shelf 5 to be folded or removed for access to shelf 4 on the G4071 stowage cart. Parts are held in place through use of form-fitting wooden blocks, straps, clamps, or ball-lock pins, or a combination of these. Sheet-metal clamps incorporate a lock device that requires only 1/4-turn to lock or unlock. Compliance with the following will aid in accomplishing efficient loading or unloading of the cart:

a. Position stowage cart in an area that provides a minimum clearance of 4 feet on all sides and a minimum overhead clearance of 3 feet.

b. Lock wheels of stowage cart prior to loading and unloading.

c. Refer to specific procedure for parts required to perform task and remove only those parts. Parts are listed in the recommended der of removal from the cart.

WARNING

Sliding shelves do not incorporate stops to prevent their removal from the cart. Pulling a shelf fully out without proper support will cause the shelf to fall; damage to equipment or injury to personnel could result.

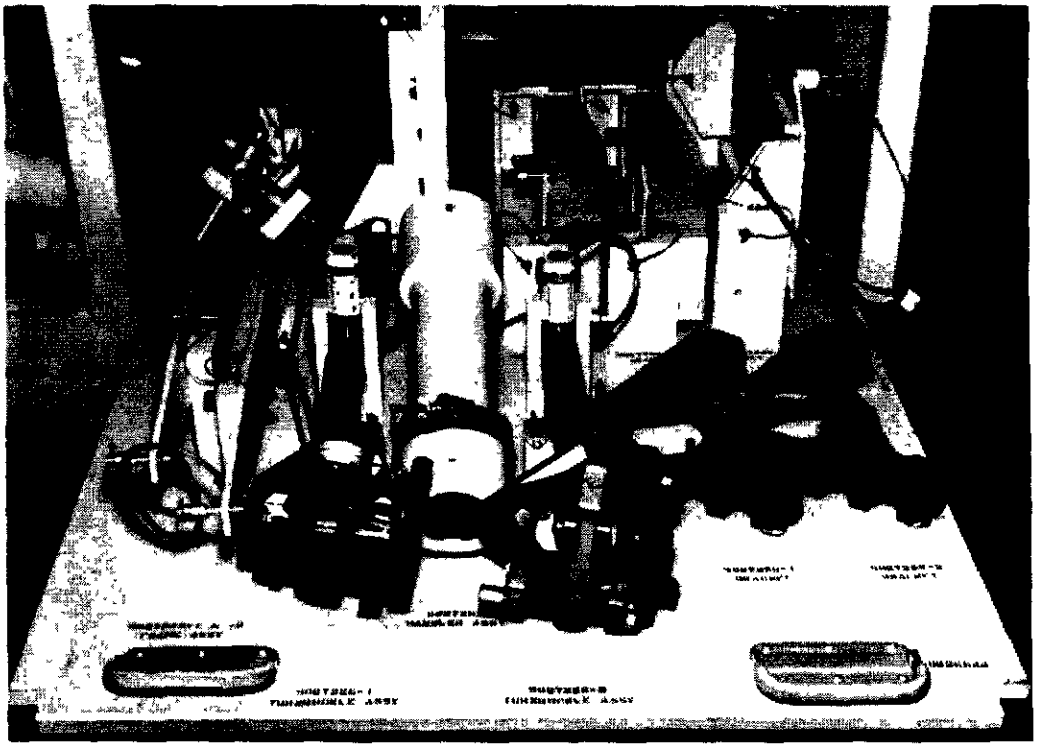
d. Partially pull sliding shelves out to remove components. Locks prevent the shelf from sliding out during movement of cart. Remove locks to pull shelf out and replace them when shelf is pushed in. See figure 2-1 for proper assembly of lock. Do not pull shelves all the way out unless removal of shelf from cart is desired.

e. If shelf on which boom is stored is difficult to move, loosen the 4 clamps that secure boom.

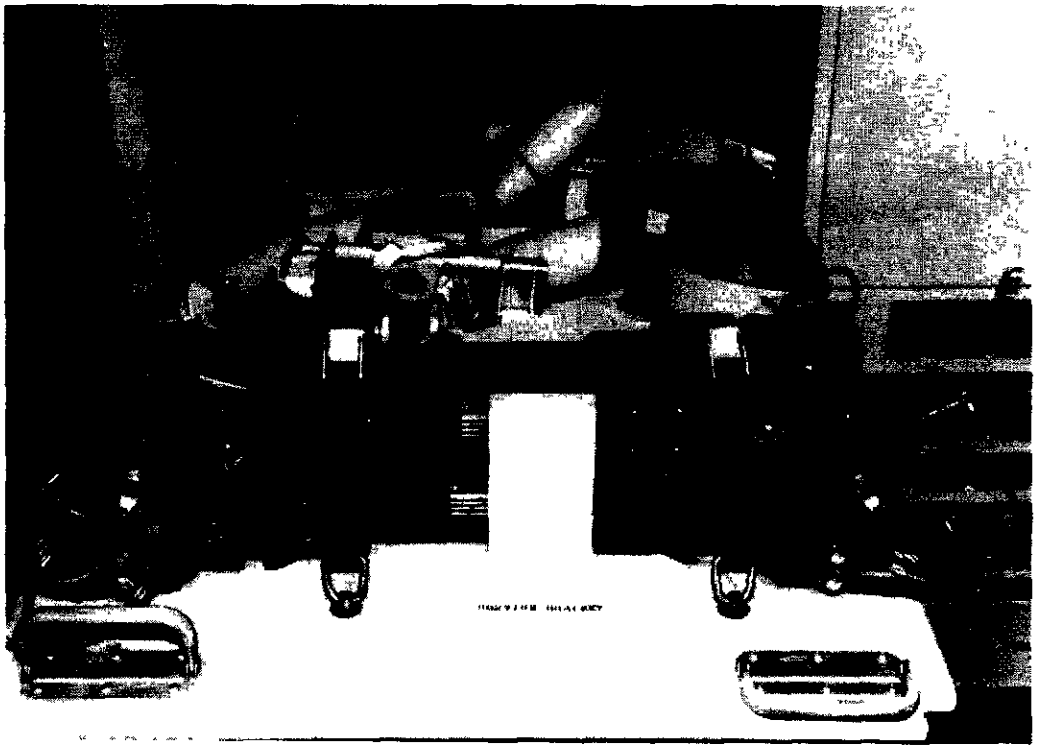
f. While handling track sections, protect track ends from damage by covering them with protective cushioning material and take care to prevent nicks in track rails.

g. The G4071 stowage cart has two sliding shelves that contain numerous small parts. For proper stowage of parts on these shelves, see figure 2-2.

Figure 2-1. Shelf Lock



SHELF 2



SHELF 3

9025865-E-1

Figure 2-2. Proper Storage of Miscellaneous Parts of G4071

T (SII STAGE).

t pr es a platform for
ere stage structure is
ort surrounds engine
ded from stage structure.
rt is necessary prior to
d any of the five engine
orts a portion of all

CK SUPPORT. Install-
quires personnel to
ace installer parts on
ive pads. Heat shield
loads be limited to a
per quadrant (including
ral forces be kept to a
olding on to heat shield
mitted. Whenever pos-
applied to the track
than the heat shield.
ht applied to the heat
ve weights of parts

ING

ds per quadrant,
ate orce to
ump...g the heat
s can result in
t and injury to

heat-shield pro-
ctions are to be
pplied to each
educing the per-
e quadrants
e: A 170-pound
dge section and
mponent, re-
eight on each
nts by 220

ecial tools:

apable of torquing
30 inch-pounds.

(2) Flexible steel tape, 12 feet long (minimum)

b. Obtain Engine Components Installer G4071 parts listed in figure 2-3 and 4 hoists G7-8215-8 (stage). (Refer to paragraph 2-4 for information on unloading stowage cart.)

c. Attach bracket assemblies 9027182, 9027182-11, and 9027182-21 to stage thrust structure, in locations shown in figure 2-4, as follows:

(1) Remove bolts that secure one clamp to bracket.

(2) Loosen bolts that secure other clamp to bracket.

(3) Center bracket assembly over beams, and position clamps with a minimum gap to bulkhead and install bolts removed in substep 1. Torque bolts to 110 ±10 inch-pounds.

d. Extend struts 9027178 and 9027178-11 to maximum length.

e. With end of strut containing right-hand thread up, attach one strut 9027178 to each hanger on inboard brackets with captive ball-lock pins. Take care not to bump or otherwise cause struts to move, since they can strike and damage engine.

f. With end of strut containing right-hand thread up, attach one strut 9027178-11 to each hanger on outboard brackets with captive ball-lock pins.

g. Install a protective pad on the lower 1/3 of each stage strut supporting the head shield.

h. Position platform 9027190 on heat shield protective pad (stage) between engine positions 1 and 2, with hangers up and notch in platform straddling the 2 inboard stage struts. (Platform weighs 96 pounds.)

i. Lift platform 9027190 and aline hangers with rod ends of 2 adjacent inboard struts and 2 adjacent outboard struts, and secure platform with captive ball-lock pins.

›menclature	Part Number	Number Required	Shelf Number	Deck Location
Platform	9027190	4	2 each side of cart	One between each two outboard engine positions
Beam	9027188	4	3	One between each two outboard engine positions
Bracket	9027182	4	3	Engine positions 2, 3 and 4
Bracket	9027182-11	1	3	Engine position 3
Bracket	9027182-21	3	3	Engine positions 1, 2, and 4
Strut	9027178	8	2	Two between each two outboard engine positions
Strut	9027178-11	8	2	Two between each two outboard engine positions

Figure 2-3. G4071 Parts Required to Install Track Support

j. Connect and adjust stage hoist cable as shown in figure 2-5.

k. Install 3 remaining platforms 9027190 between engine positions 2 and 3, 3 and 4, and 4 and 1 as in steps h through j.

Center one beam (boltheads up) between ea.. 2 platforms and aline slots with boltholes in platform arms. (See figure 2-6.) Install captive bolts fingertight. (Each beam weighs 52 pounds.)

m. Level each platform by adjusting height of platform to dimension shown in figure 2-7. Mark cover (not illustrated) protecting strut. Do not impression-stamp. After leveling, secure strut rod ends by torquing nuts to 75-100 inch-pounds.

NOTE

Any lateral movement of platforms after alinement negates leveling.

n. Maintaining platforms level (step m), torque bolts that secure beams to platforms to 340-430 inch-pounds.

o. Remove hoist (stage).

2-9. REMOVING TRACK SUPPORT. Disassembly and removal requirements for the track support are obvious and require no special procedures. Heat shield limitations require that loads ›e limited to a maximum of 400 pounds per quad (including bridge sections) and lateral orc e kept to a minimum. Bumping or holding onto heat shield support struts is not permitted. Whenever possible, the loads must be applied to the track support structure rather than the heat shield To calculate weight applied to heat shield, allow 96 pounds for each platform and 52 pounds for each beam. (See figure 2-6 for identifying platforms and beams.) Refer to section I for storage location of track support parts and install them in cart in reverse order of that listed in figure 2-3.

WARNING

Exceeding 400 pounds per quadrant, applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

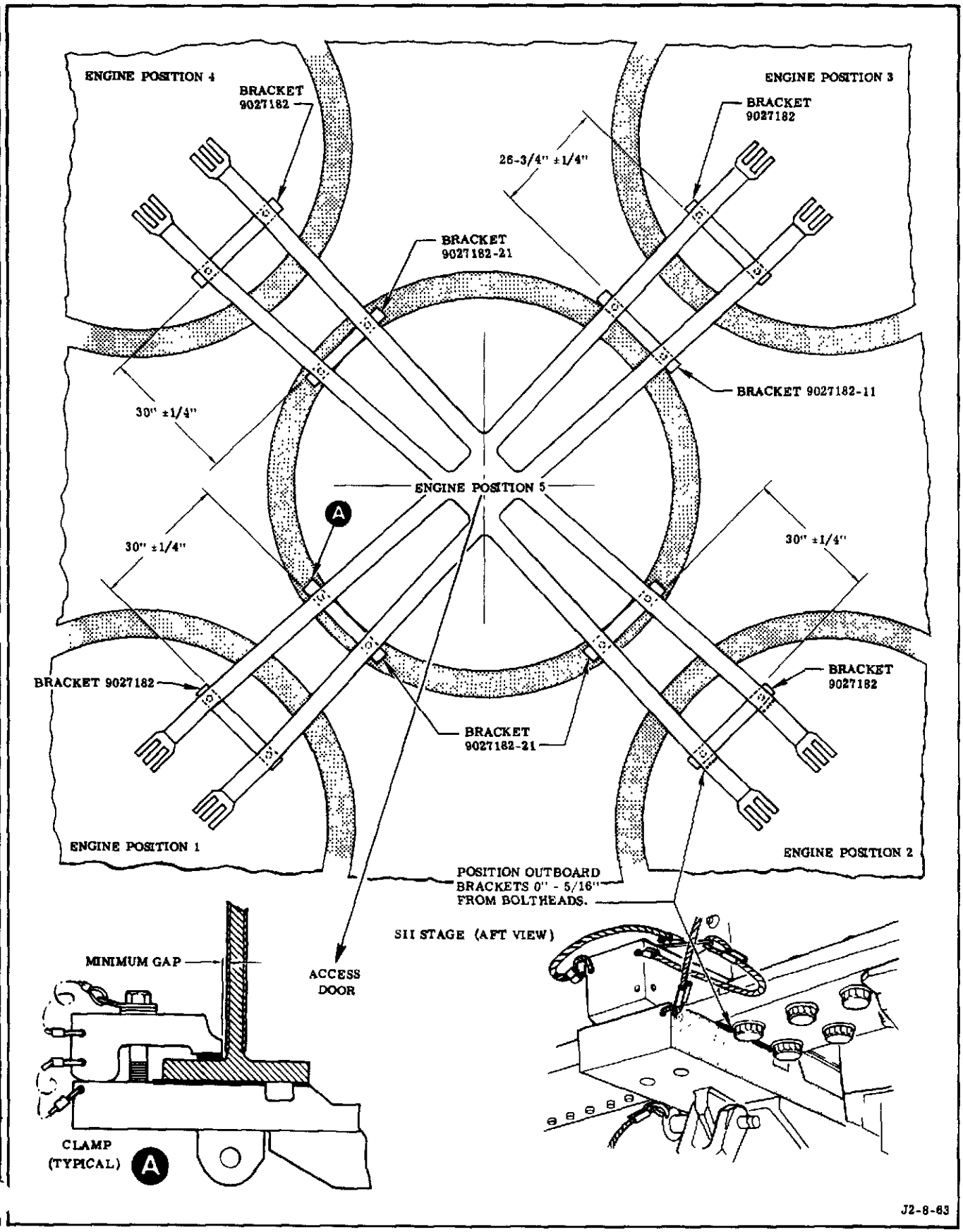


Figure 2-4. Location of Brackets 9027182

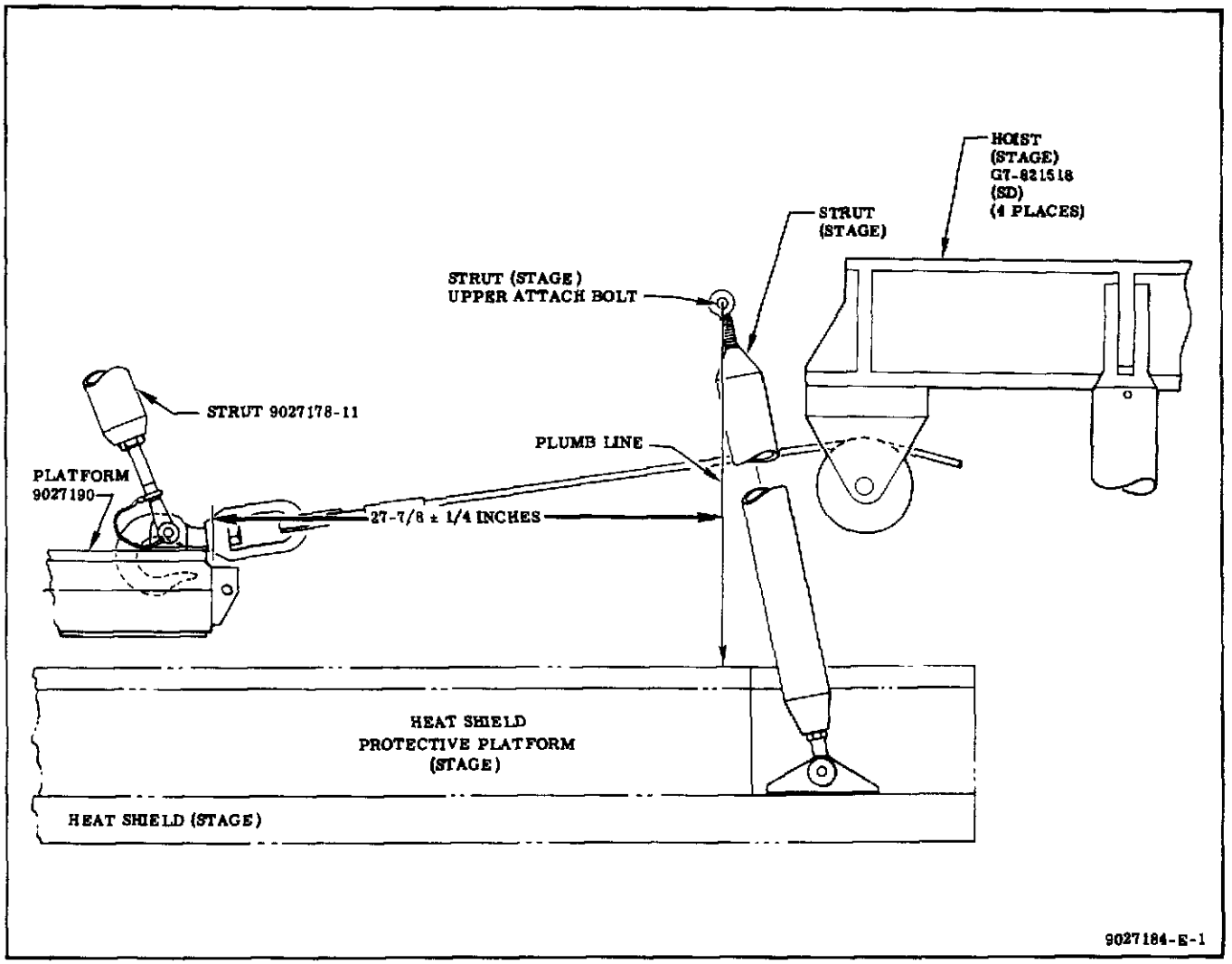


Figure 2-5. Positioning Platform

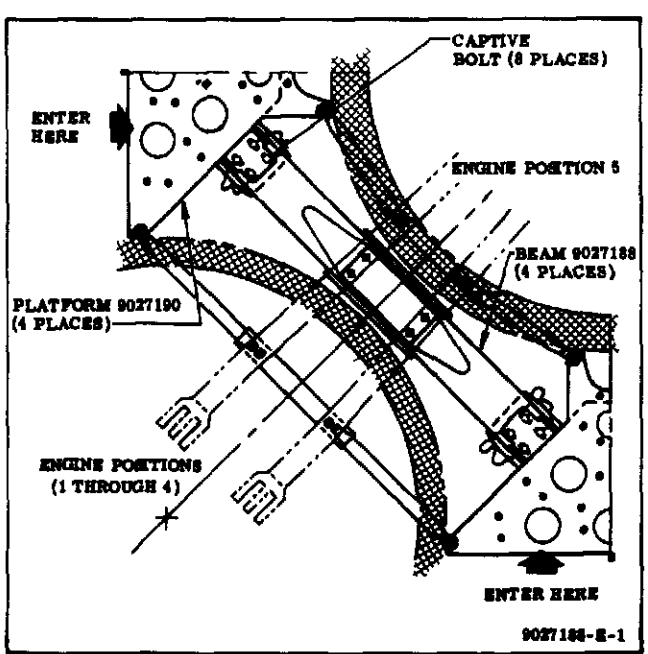


Figure 2-6. Beam Installed

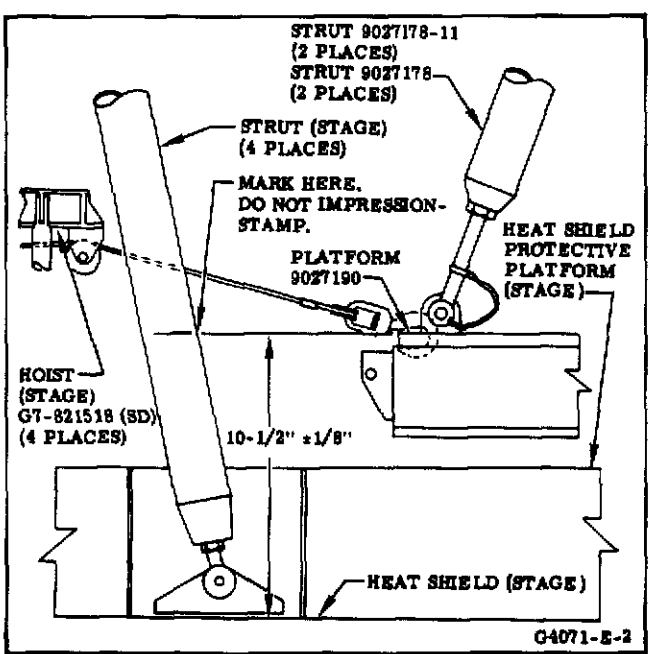


Figure 2-7. Platform 9027190 Installed Height

2-10. TRACK AND HOIST.

2-11. The track and hoist are the direct means for supporting and transporting a component.

2-12. The G4071 and 9026251 provide five individual track configurations for the SII stage, one for each engine. Track configurations are similar in that they each provide a continuous track that virtually surrounds the affected engine and is supported by the stage work platform and the track support (paragraph 2-6). Heat shield limitations require that loads be limited to a maximum of 400 pounds per quadrant (including bridge sections) and lateral forces be kept to a minimum. Bumping or holding onto heat shield support struts is not permitted. Whenever possible, the loads must be applied to the track support structure rather than the heat shield. To aid in calculating weight applied to heat shield, the procedures give weights of parts exceeding 50 pounds.

WARNING

Exceeding 400 pounds per quadrant, applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

2-13. The G4072 provides six track configurations for the SIVB stage. The track configurations are determined by component removal and installation requirements.

2-14. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 1). When installed, the track appears as shown in figure 2-8.

a. Install track support (paragraph 2-8).

b. Obtain the following special tools:

(1) Torque wrench capable of torquing 340-430 inch-pounds.

(2) Spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent.

c. Obtain Engine Components Installer G4071 parts listed in figure 2-9. (Refer to paragraph 2-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 1 and 5. (See figure 2-10.) Install captive bolts but do not tighten.

e. Place a base on platforms adjacent to engine position 1 in locations shown in figure 2-10. Do not install captive bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

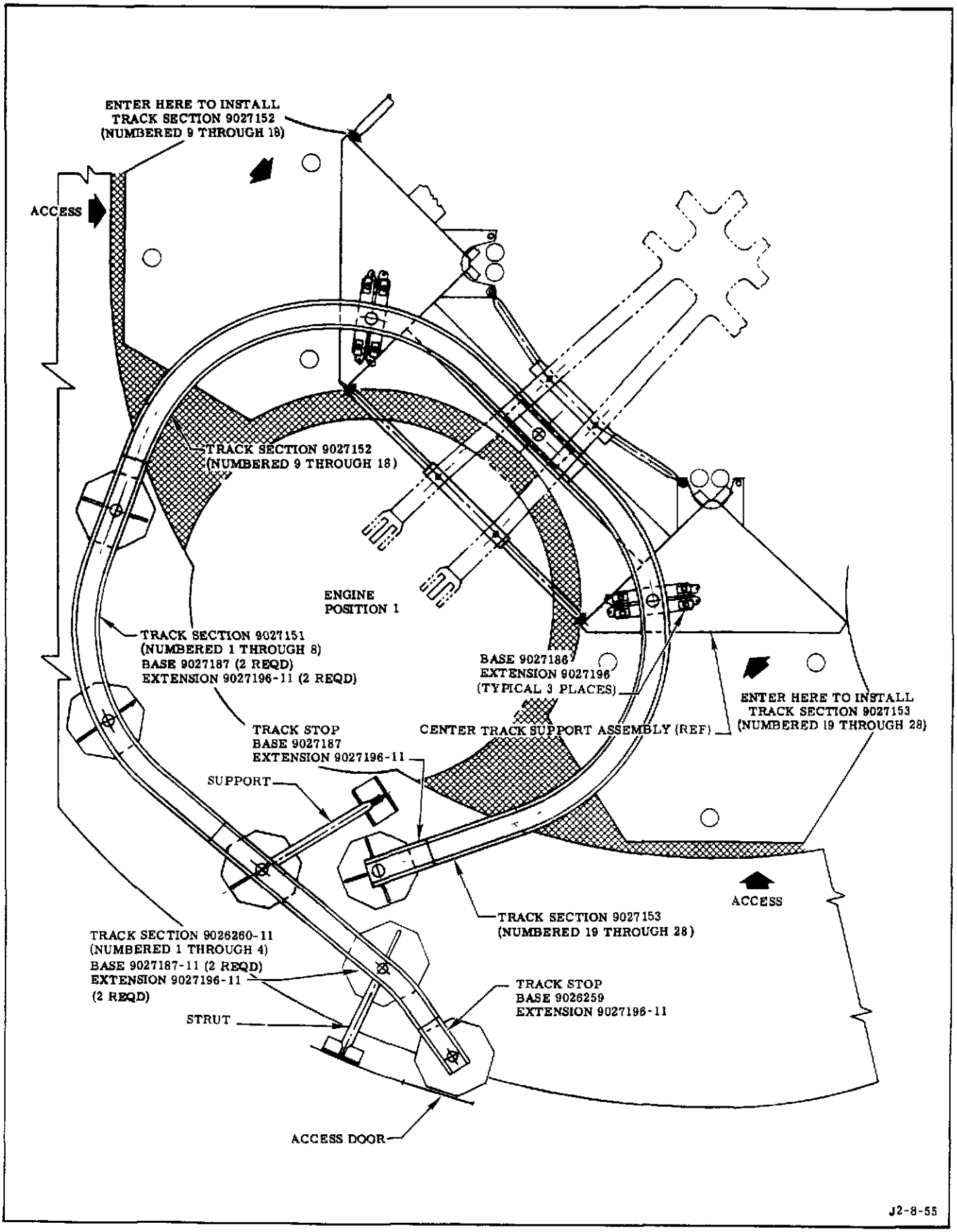


Figure 2-8. Location of Track Components for Engine Position 1

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9027153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Support	9027200		4
Track pin	9027160	5	3
Support pin	9027161	9	3
Base	9027186	3	2
Base	9027187	3	2
Base	9027187-11	2	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	6	1
Base	9026259		(a)
Strut	9026270		(a)

(a) Part of component installer set 9026251

Figure 2-9. Parts Required to Install Track for Engine Position 1

g. Insert an extension 9027196 into each base n platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 2-8 as follows: (Track section 9027152 weighs 94 pounds.)

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extensions with support pins. (See figure 2-11.) Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 2-10) and install but do not tighten captive bolts.

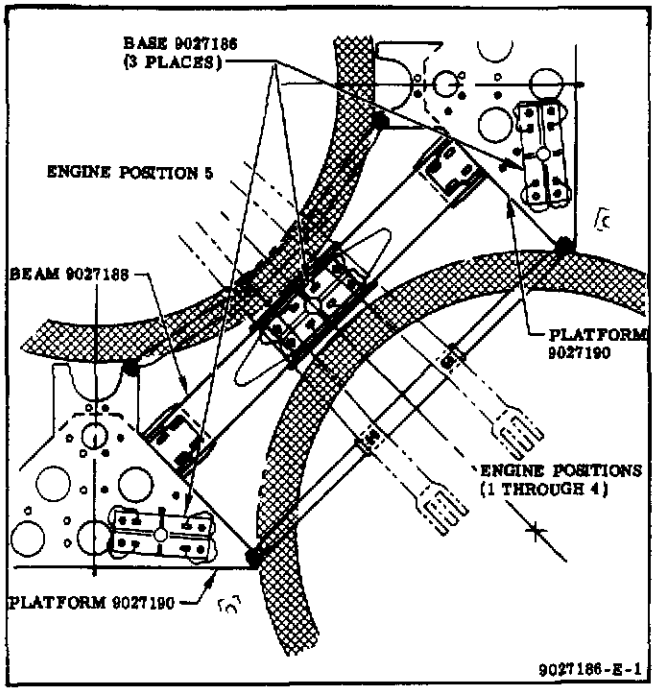


Figure 2-10. Location of Bases 9027186

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track sections must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 2-8 as follows: (Track section 9027153 weighs 86 pounds.)

(1) Position track over extension on platform; lower track section onto extension, moving base and extension to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 2-12 for typical installation.)

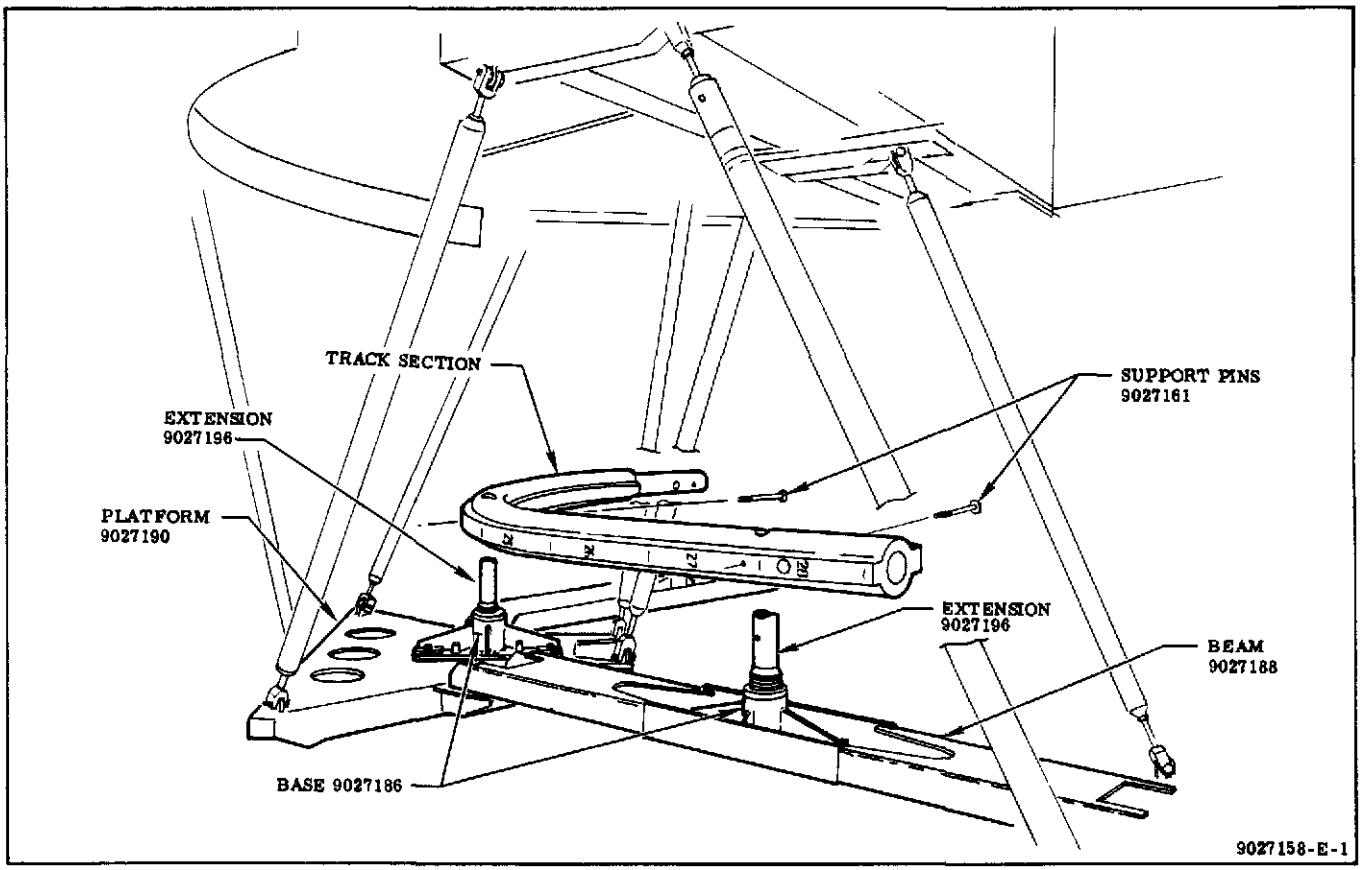


Figure 2-11. Positioning Track Section

(4) Join tracks and secure with track pin. (See figure 2-13) for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 2-10) and install but do not tighten captive bolts.

(6) Place a base 9027187 with an extension 9027196-11 approximately 2 feet from end of track section 9027153 (numbered 19 through 28).

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline track section 9027153; then push stop onto track section and secure with a track pin.

(9) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

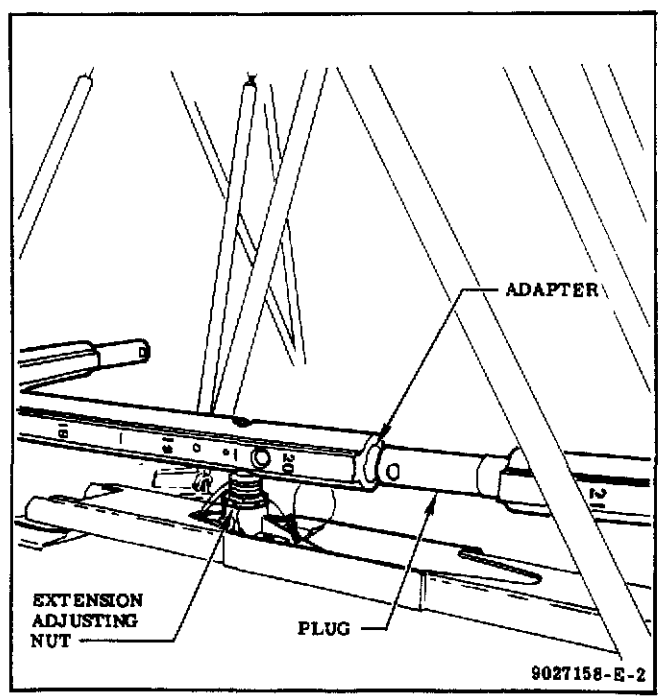


Figure 2-12. Alining Track Section

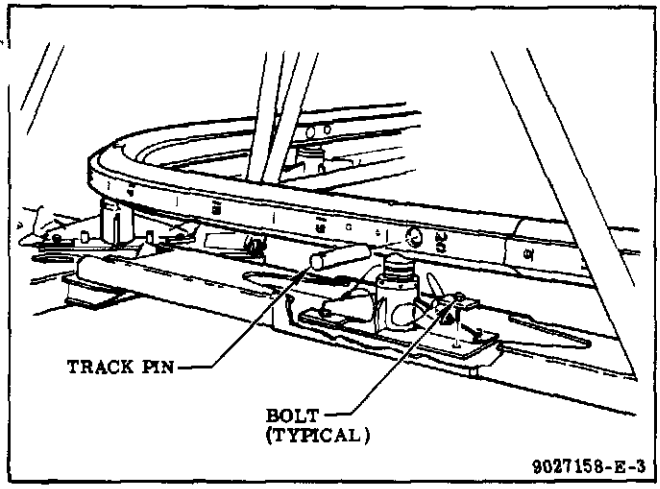


Figure 2-13. Securing Track Section

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 2-8 as follows:

(1) Place 2 bases 9027187 on stage work deck in locations shown in figure 2-8 and insert an extension 9027196-11 into each base.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 2-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Install track section 9026260-11 (numbered 1 through 4) in location shown in figure 2-8 as follows:

(1) Place 2 bases 9027187-11 on stage work deck in approximate locations shown in figure 2-8. Orient base lugs as shown.

(2) Place base 9026259 on stage access door step as shown in figure 2-8.

(3) Insert remaining extensions 9027196-11 into bases.

(4) Secure track section to extensions with upport pins. Tighten pins sufficiently to seat.

(5) Adjust height of extensions to aline track section with installed track. (See figure 2-12 for typical installation.)

(6) Join tracks and secure with a track pin. (See figure 2-13 for typical installation.)

(7) Verify that vertical adjustments of extensions supporting track are within 1/8 inch of each other.

l. Install support (figure 2-14) on base as shown in figure 2-8.

m. Install strut (figure 2-15) on base in location shown in figure 2-8.

n. Torque bolts that secure bases to platforms and beam to 340-430 inch-pounds.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

o. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on track section 9026260-11 (numbered 1 through 4).

p. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

q. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

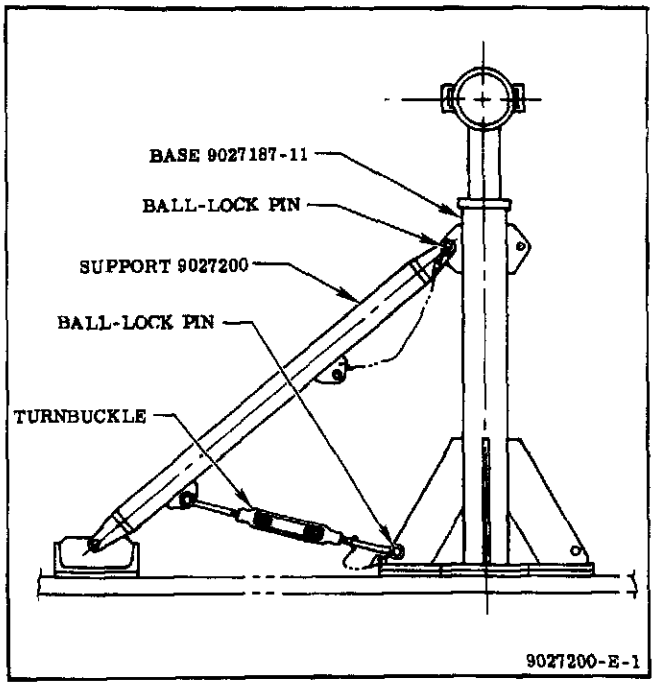


Figure 2-14. Support Installed

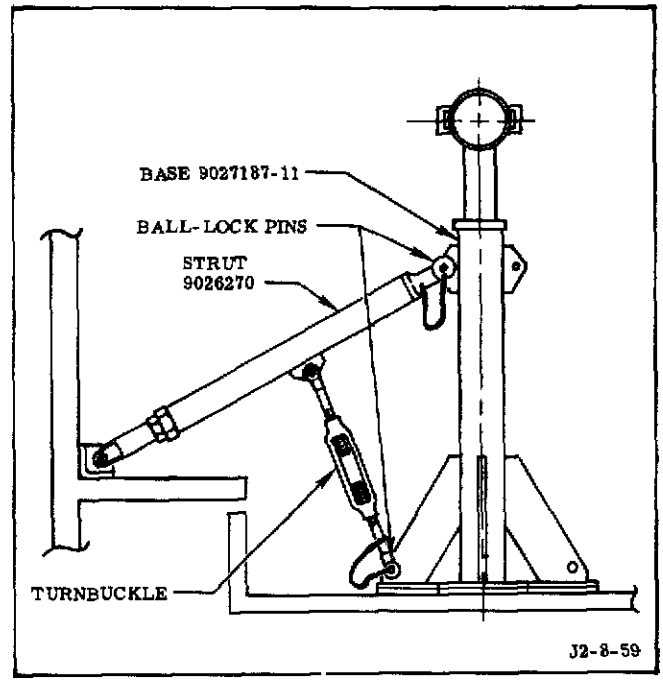


Figure 2-15. Strut Installed

r. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow strut to be extended beyond safe limits, causing damage to equipment and injury to personnel.

s. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

2-15. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 2). When installed, the track appears as shown in figure 2-16.

a. Install track support (paragraph 2-8).

b. Obtain the following special tools:

(1) Torque wrench, 0-150 inch-pounds

(2) Torque wrench, 0-500 inch-pounds

(3) Spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent

c. Obtain Engine Components Installer G4071 parts listed in figure 2-17. (Refer to paragraph 2-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 2 and 5. (See figure 2-10.) Install captive bolts but do not tighten.

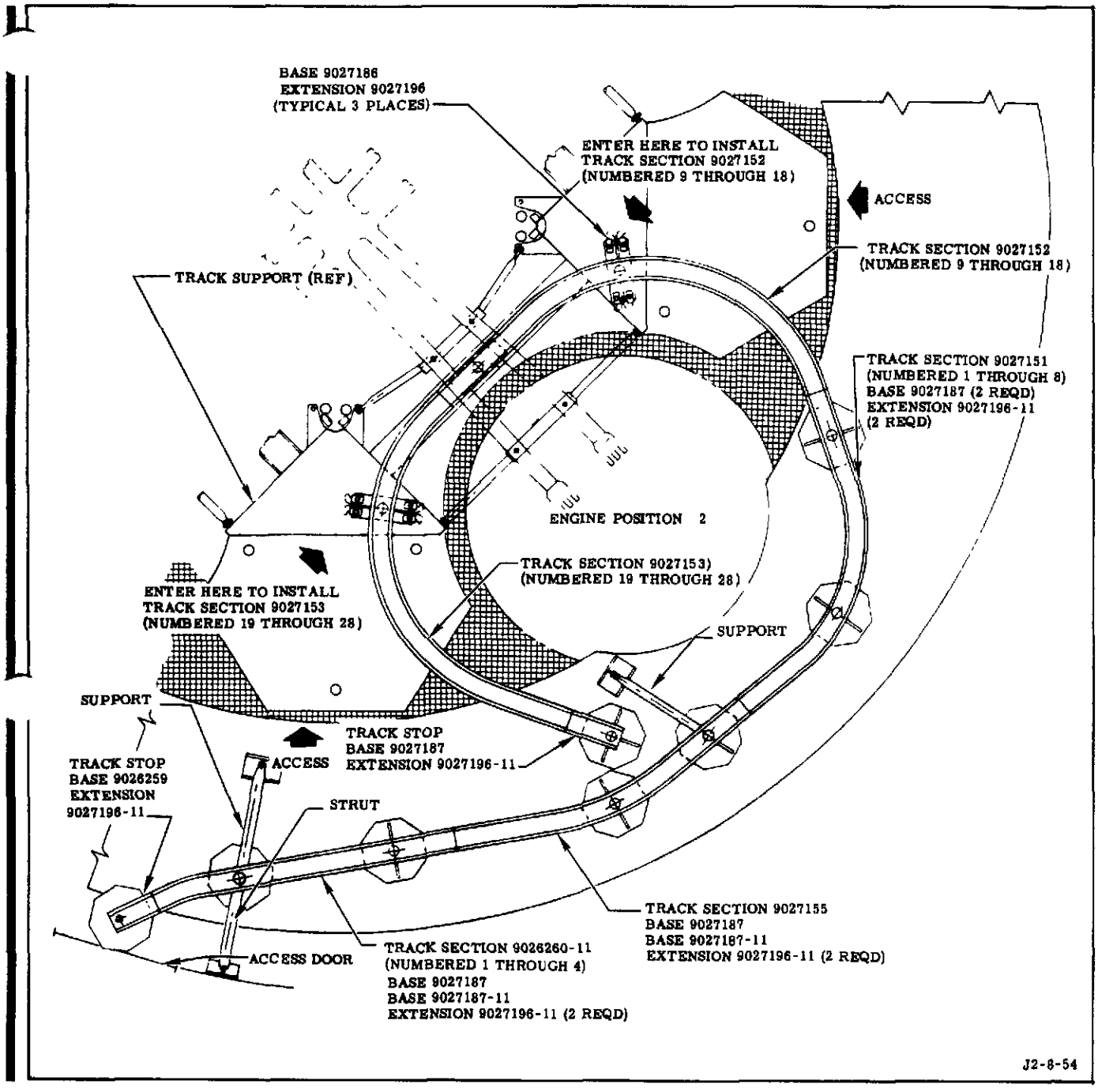


Figure 2-16. Location of Track Components for Engine Postion 2

e. Place a base on each platform adjacent to engine position 2 in location shown in figure 2-10. Do not install bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

g. Insert an extension 9027196 into each base on platforms and beam.

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9028153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Track section	9027155		4
Support	9027200	2	4
Track pin	9027160	6	3
Support pin	9027161	11	3
Base	9027186	3	2
Base	9027187	5	2
Base	9027187-11	2	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	8	1
Strut	9026270		(a)
Base	9026259		(a)

(a) Part of components installer set 9026251

Figure 2-17. Parts Required to Install Track for Engine Position 2

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 2-16, as follows: (Track section 9027152 weighs 94 pounds.):

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt patter (see figure 2-10) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 2-16 as follows: (Track sect'on 9027153 weighs 86 pounds.)

(1) Position track section over extension on platform; lower track section onto extension, moving base and extension to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 2-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 2-10) and install captive bolts but do not tighten.

(6) Place a base 9027187 with an extension 9027196-11 approximately 2 feet from end of track section 9027153.

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline stop with track section 9027153; then push stop onto track section and secure with track pin.

(9) Verify that vertical adjustment of extension on which track section is mounted is within 1/8 inch of extension on beam.

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 2-16 as follows:

(1) Place 2 bases 9027187 on stage work deck in locations shown in figure 2-16 and insert an extension 9027196-11 into each base.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 2-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Install track section 9027155 (not numbered) in location shown in figure 2-16 as follows:

(1) Place 2 bases with extensions on stage work deck in locations shown in figure 2-16. Orient base incorporating lugs as shown.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 2-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

l. Install a support (figure 2-14) on base of track section 9027155 in location shown in figure 2-16.

m. Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

n. Install track section 9026260-11 (numbered 1 through 4) in location shown in figure 2-16 as follows:

(1) Place 2 bases 9027187 and 9027187-11 with extensions on stage work deck in approximate locations shown in figure 2-16. Orient base incorporating lugs as shown.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Secure track section to extension with support pins. Tighten pins sufficiently to seat.

(4) Adjust height of extensions to aline track section with installed track. (See figure 2-12 for typical installation.)

(5) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

o. Install remaining support (figure 2-14) on base in location shown in figure 2-16.

p. Install strut (figure 2-15) on base in location shown in figure 2-16.

q. Torque bolts that secure bases to platforms and beam to 340-430 inch-pounds.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

r. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on track section 9027155 (not numbered).

s. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

t. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

u. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow the strut to be extended beyond safe limits, causing damage to equipment and injury to personnel.

v. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through hole in rod ends.

2-16. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 3.) When installed, the track will appear as shown in figure 2-18.

a. Install track support (paragraph 2-8).

b. Obtain the following special tools:

(1) Torque wrench, 0-150 inch-pounds

(2) Torque wrench, 0-500 inch-pounds

(3) Spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent

c. Obtain Engine Components Installer G4071 parts listed in figure 2-19. (Refer to paragraph 2-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 3 and 5. (See figure 2-10.) Install captive bolts but do not tighten.

e. Place a base on each platform adjacent to engine position 3 in location shown in figure 2-10. Do not install bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads using Molykote G paste (Dow Corning Corp).

g. Insert an extension 9027196 into each base on platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 2-18 as follows: (Track section 9027152 weighs 94 pounds.)

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 2-12) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

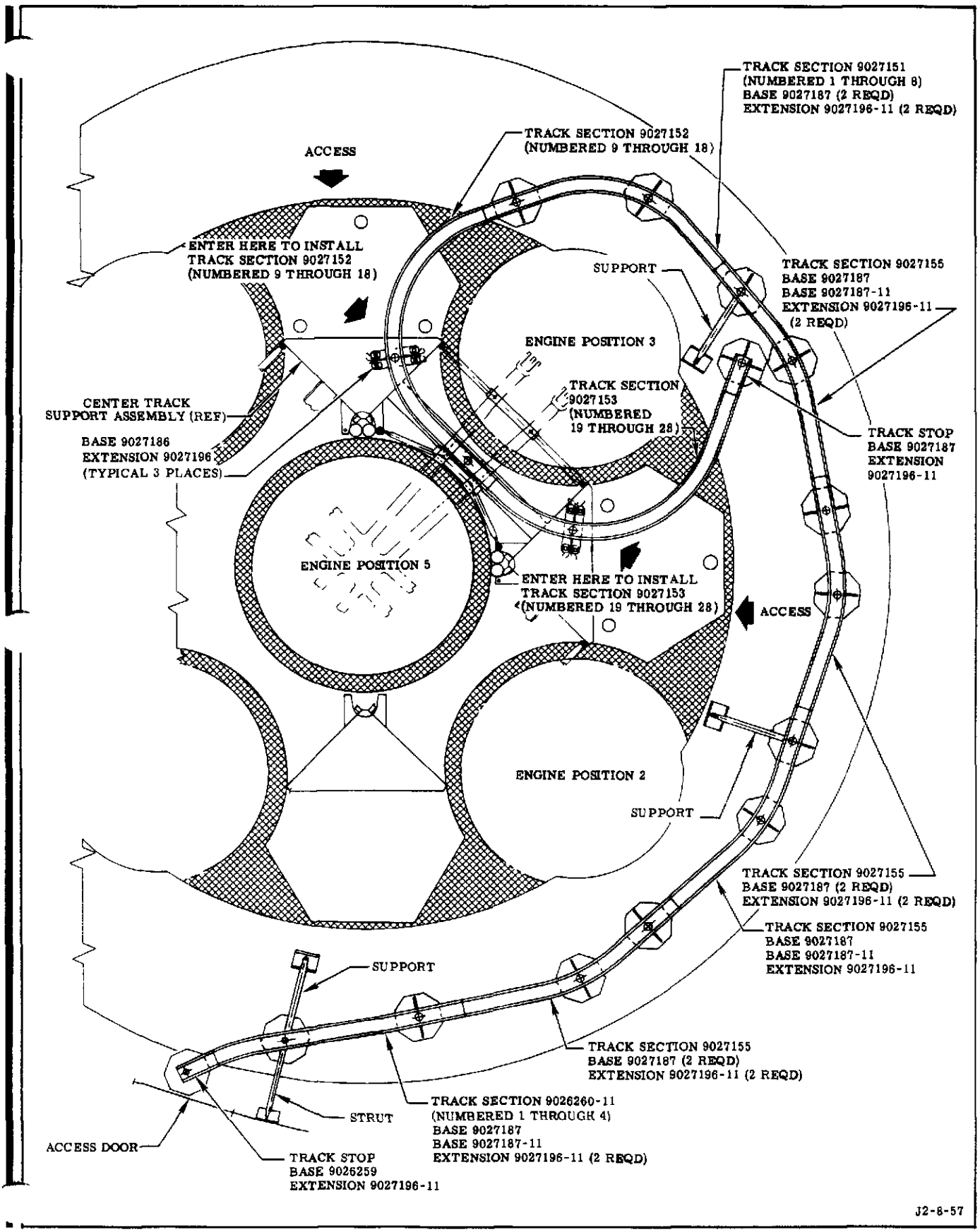


Figure 2-18. Location of Track Components for Engine Position 3

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9027153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Track section	9027155	4	4
Support	9027200	3	4
Track pin	9027160	9	3
Support pin	9027161	17(b)	3
Base	9027186	3	2
Base	9027187	10	2
Base	9027187-11	3	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	13	1
Strut	9026270		(a)
Base	9026259		(a)
Extension	9027196-11		(a)

(a) Part of components installer set 9026251
(b) G4071 has 16 only. (Procure one from spares, G4072, or 9026252.)

Figure 2-19. Parts Required to Install Track for Engine Position 3

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 2-18 as follows: (Track section 9027153 weighs 86 pounds.)

(1) Position track section over extension on platform; lower track section over extension, moving base and extension to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 2-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

(5) Aline base on platform over proper bolt pattern (see figure 2-10) and install captive bolts but do not tighten.

(6) Place a base 9027187 with an extension 9027196-11 approximately 2 feet from end of track section 9027153.

(7) Position stop (boltheads down) on extension and secure with support pin. Tighten pin sufficiently to seat.

(8) Adjust height of extension to aline stop with track section 9027153 (numbered 19 through 28); then push stop onto track section and secure with a track pin.

(9) Verify that vertical adjustment of extension on which track section is mounted is within 1/8 inch of extension located on beam.

j. Install track section 9027151 (numbered 1 through 8) in location shown in figure 2-18 as follows:

(1) Place 2 bases 9027187 with extensions on stage work deck in locations shown in figure 2-18.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track section. (See figure 2-12 for typical installation.)

(4) Join tracks and secure with track pin. (See figure 2-13 for typical installation.)

(5) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Install each of 4 track sections 9027155 (not numbered), consecutively, in locations shown in figure 2-18 as follows:

(1) Place 2 bases with extensions on stage work deck in locations shown in figure 2-18. Orient base incorporating lugs as shown.

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track sections with installed track. (See figure 12 for typical installation.)

(4) Join tracks and secure with a track pin. (See figure 2-13 for typical installation.)

l. Install a support (figure 2-14) on base of track section 9027155, in locations shown in figure 2-18.

m. Verify that vertical adjustments of extensions on which track sections are mounted are within 1/8 inch of each other.

n. Install track section 9026260-11 (numbered 1 through 4) in locations shown in figure 2-18 as follows:

(1) Place 2 bases 9027187 and 9027187-11 with extensions on stage work deck in locations shown in figure 2-18. Orient base incorporating lugs as shown.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(4) Adjust height of extensions to aline track section with installed track. (See figure 12 for typical installation.)

(5) Joint tracks and secure with track pin. (See figure 2-13 for typical installation.)

(6) Verify that vertical adjustments of extensions which track section is mounted are within 1/8 inch of each other.

o. Install remaining support (figure 2-14) on base in location shown in figure 2-18.

p. Install strut (figure 2-15) on base in location shown in figure 2-18.

q. Torque bolts that secure bases to platforms and beams to 340-480 inch-pounds.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

r. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining track elevation to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027153 (numbered 19 through 28) to intersect matching surface on adjacent track section 9027155 (not numbered).

s. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

t. Install stop (boltheads down) on track section 9026260-11 (numbered 1 through 4) and secure with track pin.

u. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow strut to be extended beyond safe limits, causing damage to equipment and injury to personnel.

v. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

2-17. INSTALLING TRACK AND HOIST (SII STAGE, ENGINE POSITION 4). When installed, the track appears as shown in figure 2-20.

a. Install track support (paragraph 2-8).

b. Obtain the following special tools:

(1) Torque wrench, 0-150 inch-pounds

(2) Torque wrench, 0-500 inch-pounds

(3) Spanner wrench, 3-1/2 inches, No. 462 (J. H. Williams and Co), or equivalent

c. Obtain Engine Components Installer G4071 parts listed in figure 2-21. (Refer to paragraph 2-4 for information on unloading stowage cart.)

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

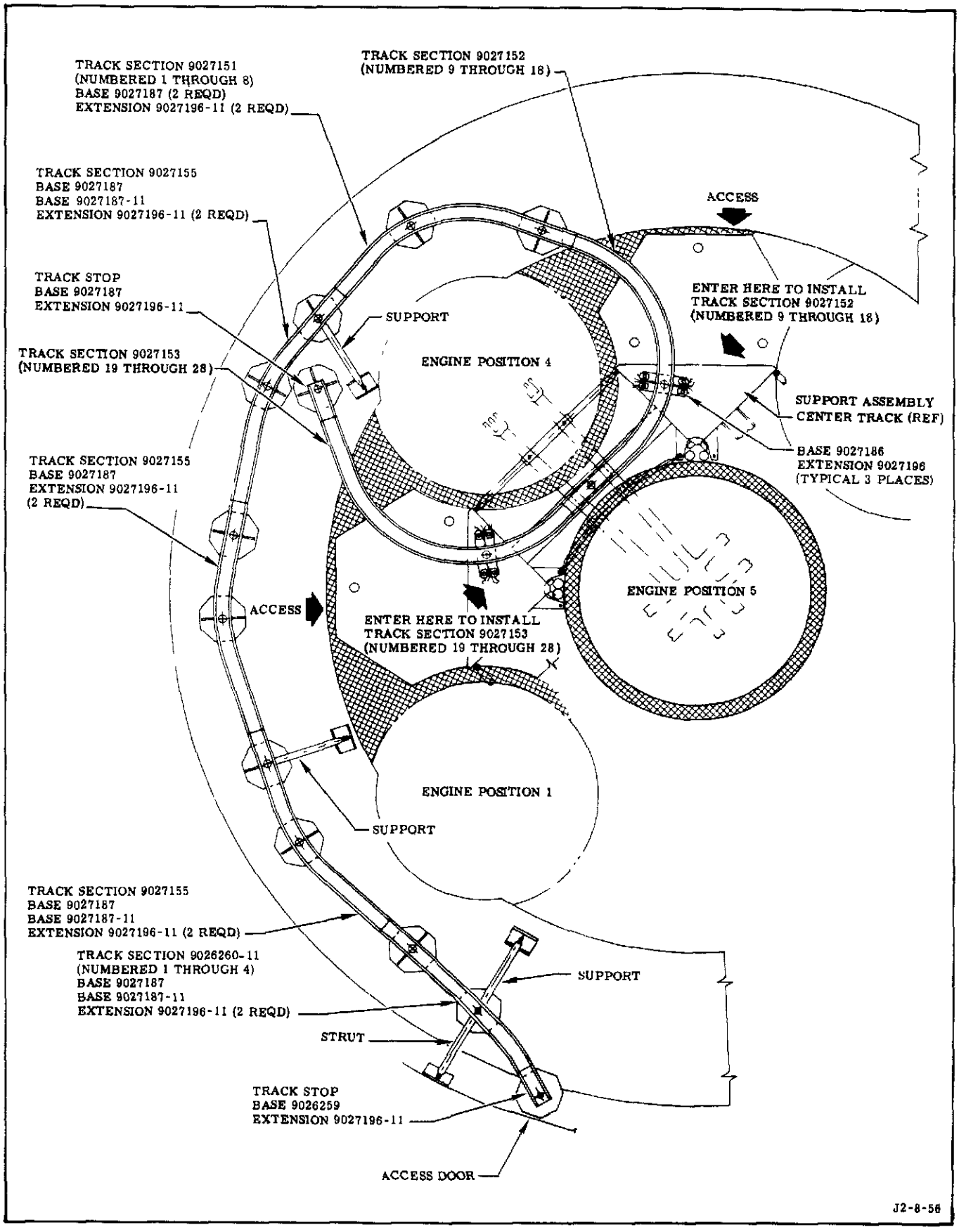


Figure 2-20. Location of Track Components for Engine Position 4

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

d. Place a base in center of beam between engine positions 4 and 5. (See figure 2-10.) Install captive bolts but do not tighten.

e. Place a base on each platform adjacent to engine position 4 in location shown in figure 2-10. Do not install bolts at this time; however, thread one captive bolt fingertight into an available hole in platform so that cable acts as a lanyard to prevent base from falling.

f. Adjust nuts of extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads using Molykote G paste (Dow Corning Corp).

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)
Track section	9027151		5
Track section	9027152		5
Track section	9027153		5
Track stop	9027156	2	5
Track section	9026260-11		(a)
Track section	9027155	3	4
Support	9027200	3	4
Track pin	9027160	8	3
Support pin	9027161	15	3
Base	9027186	3	2
Base	9027187	8	2
Base	9027187-11	3	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196	3	1
Extension	9027196-11	12	1
Strut	9026270		(a)
Base	9026259		(a)

(a) Part of components installer set 9026251

Figure 2-21. Parts Required to Install Track for Engine Position 4

g. Insert an extension 9027196 into each base on platforms and beam.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

h. Install track section 9027152 (numbered 9 through 18) in location shown in figure 2-20 as follows: (Track section 9027152 weighs 94 pounds.)

(1) Position track section over extensions on beam and platform; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Aline base on platform over proper bolt pattern (see figure 2-10) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

i. Install track section 9027153 (numbered 19 through 28) in location shown in figure 2-20 as follows:

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

(1) Position track section over extension on platform; lower track section over extension, moving base and extension, as necessary, to aline with track. (See figure 2-11 for typical installation.)

(2) Secure track section to extension with support pin. Tighten pin sufficiently to seat.

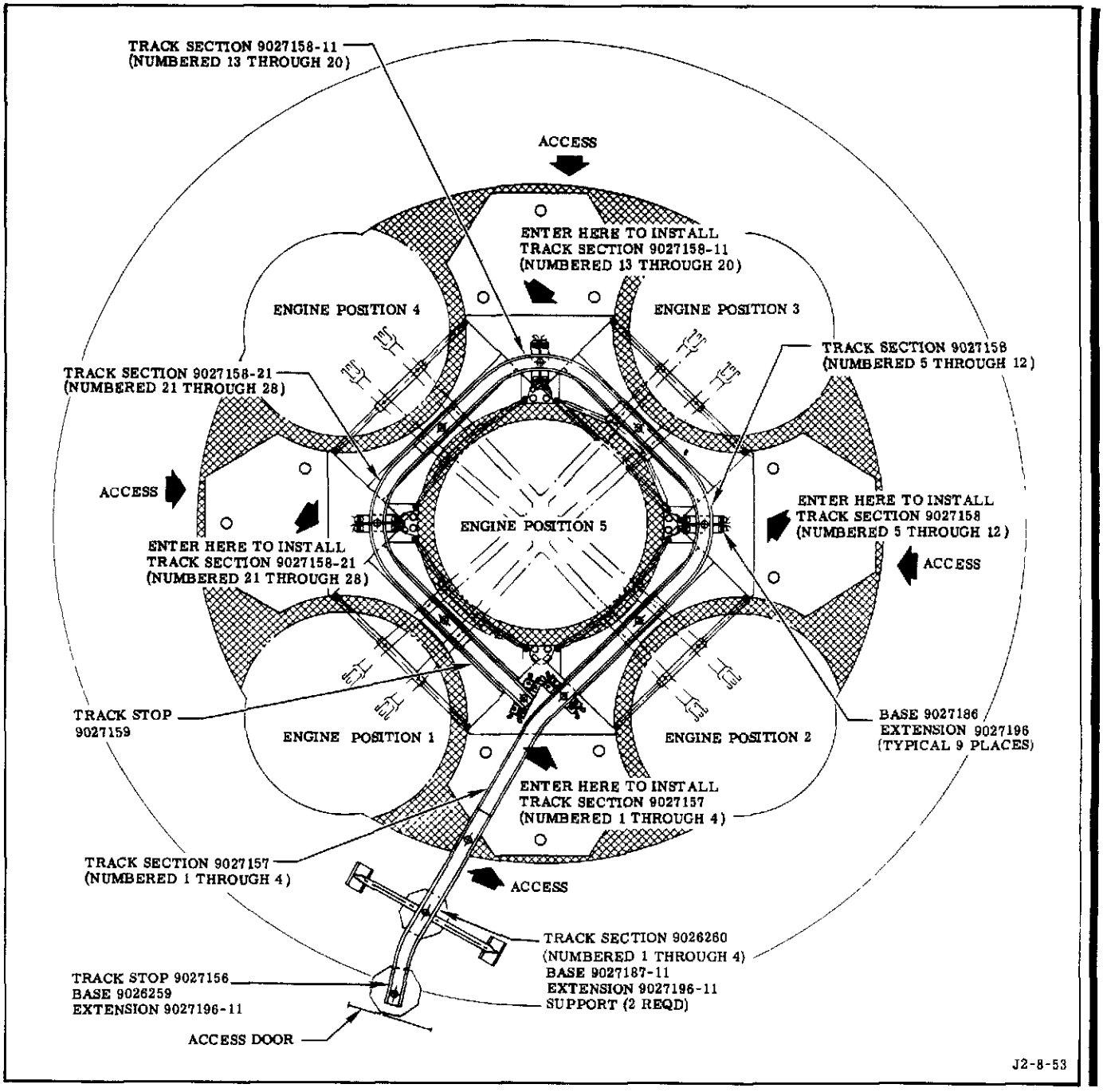


Figure 2-22. Location of Track Components for Engine Position 5

h. Rotate adjusting nuts of all extensions 9027196 and 9027196-11 to center (within 1/8 inch) of threaded area. If nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

i. Insert an extension 9027196 into each previously placed base.

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number (if part of G4071)	Deck Location
Track section (numbered 5 through 12)	9027158		5	Between engine positions 2 and 3
Track section (numbered 13 through 20)	9027158-11		5	Between engine positions 3 and 4
Track section (numbered 21 through 28)	9027158-21		5	Between engine positions 1 and 4
Track stop	9027156		5	Between engine position 2 and stage access door
Track stop	9027159		5	Between engine position 4 and stage access door
Track section (numbered 1 through 4)	9027157		4	Between engine position 2 and stage access door
Track section	9026260		(a)	Between engine position 2 and stage access door
.pport	9027200	2	4	Between engine position 1 and stage access door
Support pin	9027161	9	3	Between engine position 2 and stage access door
Track pin	9027160	6	3	Between engine position 2 and stage access door
Base	9027186	9	2	Two each with items 1, 2, 3, and 6; with item 5
Base	9027187-11		2	Between engine position 4 and stage access door
Turntable	9027101		2	Near access door
Boom	9027051		2	Near access door
Extension	9027196-11		2	Between engine position 4 and stage access door
Extension	9027196	9	1	Two each with items 1, 2, 3, and 6; 1 with item 5
Base	9026259		(a)	Between engine position 2 and stage access door.

(a) Part of components installer set 9026251

Figure 2-23. Parts Required to Install Track for Engine Position 5

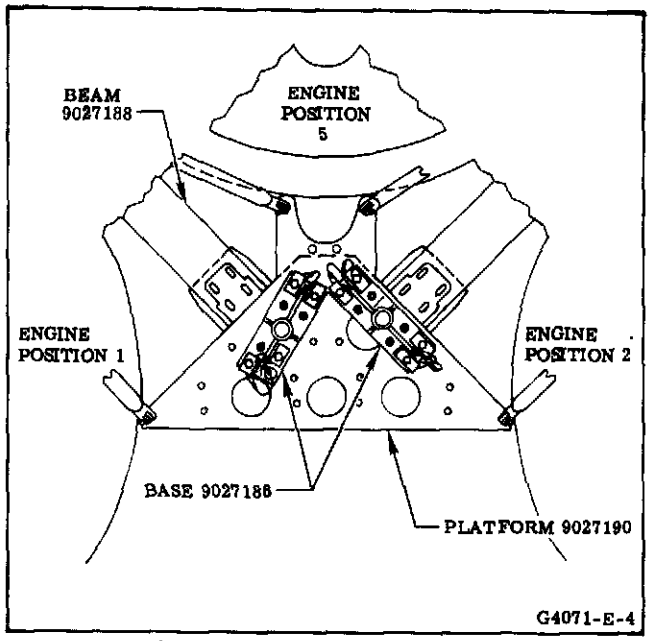


Figure 2-24. Location of Bases 9027186 for Engine Position 5

j. Install track section 9027158-21 (numbered 21 through 28) in location shown in figure 2-22 as follows:

(1) Position track section over extensions; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

NOTE

Base nearest engine position 1 will pick up 3 boltholes only.

(3) Aline base on platform over proper bolt pattern (see figure 2-24) and install captive bolts but do not tighten.

(4) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

k. Place stop 9027159 (boltheads down) on extension on platform in location shown in figure 2-22 and secure with a support pin. Tighten pin sufficiently to seat.

l. Adjust height of extension, as necessary, to aline stop with track. Join stop with track and secure with track pin.

m. Aline base on platform as shown in figure 2-22 and install captive bolts but do not tighten.

n. Verify that vertical adjustments of extensions supporting track section 9027158-21 and stop are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

o. Install track section 9027158-11 (numbered 13 through 20) in location shown in figure 2-22 as follows:

(1) Position track section over extensions; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 2-12.)

(4) Join tracks and secure with track pin. (See figure 2-13.)

(5) Aline base of platform and beam over proper bolt pattern (see figure 2-22) and install captive bolts but do not tighten.

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

p. Install track section 9027158 (numbered 5 through 12) in location shown in figure 2-22 as follows:

(1) Position track section over extensions; lower track section onto extension, moving extension and base platform to aline with track. (See figure 2-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extension to aline track section with installed track. (See figure 2-12.)

(4) Join tracks and secure with track pin. (See figure 2-13.)

(5) Aline bases on platform and beam over proper bolt pattern (see figure 2-22) and install captive bolts.

(6) Verify that vertical adjustments of extensions on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

q. Install track section 9027157 (numbered 1 through 4) in location shown in figure 2-22 as follows:

(1) Position track section over extensions; lower track section onto extensions, moving extension and base on platform to aline with track. (See figure 2-11.)

(2) Secure track section to extensions with support pins. Tighten pins sufficiently to seat.

(3) Adjust height of extensions to aline track section with installed track. (See figure 2-12.)

(4) Join track sections and secure with a track pin. (See figure 2-13.)

(5) Aline bases on platform (figure 2-24) and beam over proper bolt pattern and install captive bolts but do not tighten.

(6) Verify that vertical adjustments of extension on which track section is mounted are within 1/8 inch of each other.

WARNING

The track section must be supported at all times during installation, to prevent damage to equipment and injury to personnel.

r. Install track section 9026260 (numbered 1 through 4) in location shown in figure 2-22 as follows:

(1) Place base 9027187-11 with extension on stage work deck near access door in location shown in figure 2-22.

(2) Place base 9026259 with extension on stage access door step as shown.

(3) Install track section on extension and secure with support pin. Tighten pin sufficiently to seat.

(4) Adjust extension to aline track section with installed track section.

(5) Join tracks and secure with track pin. Tighten pin sufficiently to seat.

(6) Install 2 supports 9027200 (figure 2-14) on base in location shown in figure 2-22.

s. Torque all bolts that secure bases to platforms and beams to 340-430 inch-pounds.

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

t. Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. Adjust extensions, as necessary, to aline, maintaining elevation of track to within one-inch variation for portion of track surrounding engine. To determine if elevation of track ends is within one inch, project an extension of a rail on track section 9027158-21 (numbered 21 through 28) to intersect matching surface on adjacent track section 9027157 (numbered 1 through 4).

u. Place turntable on track as follows:

(1) Place brake handle in off position (handle inboard).

(2) With controls positioned as specified in component removal procedures, aline wheels with track and roll turntable onto track beyond first track support. Lock turntable by moving brake lever outboard.

v. Install stop (boltheads down) on track section 9026260 (numbered 1 through 4) and secure with a track pin.

w. Install boom on turntable, tightening the 4 captive bolts handtight.

WARNING

Missing roll pins can allow strut to be extended beyond safe limits, causing damage to equipment and injury to personnel.

x. Check that roll pins are installed in threads of adjustable strut on top of boom. Roll pins are visible through holes in rod ends.

2-19. INSTALLING TRACK AND HOIST (SIVB STAGE). This paragraph contains illustrations of track configurations and a track assembly procedure. Each illustration title contains the names of the engine components handled by the illustrated track configuration and the vehicle stage series (200 or 500) to which the figure is applicable. The figure illustrates the assembled track and locates the parts for proper assembly. The procedure is applicable to all the illustrations and only requires the user to know the required direction (leading or trailing) of the hoist controls when installing the hoist.

NOTE

In the following procedure, whenever reference is made to a figure and its number is not given, it is to be interpreted as the figure illustrating the track configuration required for the component to be removed.

a. Locate figure illustrating required track configuration for component to be removed. (See figures 2-25 through 2-36.) Select figure on basis of ultimate component to be removed. Do not select figure on basis of a need to remove an additional component to gain access. Track configurations allow for removal of components required for access. Make sure selected figure is for applicable vehicle.

b. If figure indicates need to install access work platform, assemble and install access work platform. (Refer to paragraph 2-34.)

c. Obtain Engine Components Installer G4072 parts for selected track configuration. (See figure 2-37.)

d. Obtain a 3-1/2-inch spanner wrench, No. 462 (J. H. Williams and Co), or equivalent.

e. Place base plates in approximate location and orientation shown in figure.

f. Place a track base on each base plate.

g. Insert an extension into each track base.

h. Adjust length of each extension to 3-5/8 ±1/16 inches from center of 1/2-inch hole (at top of extension) to top of extension adjustment nut. If nut is difficult to rotate, lubricate threads with Molykote G paste (Dow Corning Corp).

i. Secure a stop to extension located at starting point in the figure. Secure stop to extension with a support pin. Tighten support pin sufficiently to seat.

j. Starting at installed stop, install remainder of parts in succession, except remaining stop, as follows:

(1) Before mating each track section, make sure mating surfaces are clean and free of burs or damage that could impair mating. If mating surfaces are burred or damaged, refer to section IV for repair.

CAUTION

Mating portions of track sections are a close tolerance fit. Dirt or damage may make proper assembly or disassembly difficult, potentially resulting in additional damage to these surfaces.

(2) Install each track section by first securing the section to its respective extension with a support pin, then mating it to previously installed part and securing with a track pin. Tighten support pins until seated, and install track pins so pins do not protrude beyond outer surfaces of track.

(3) Position track to meet dimensional requirements of figure during track assembly.

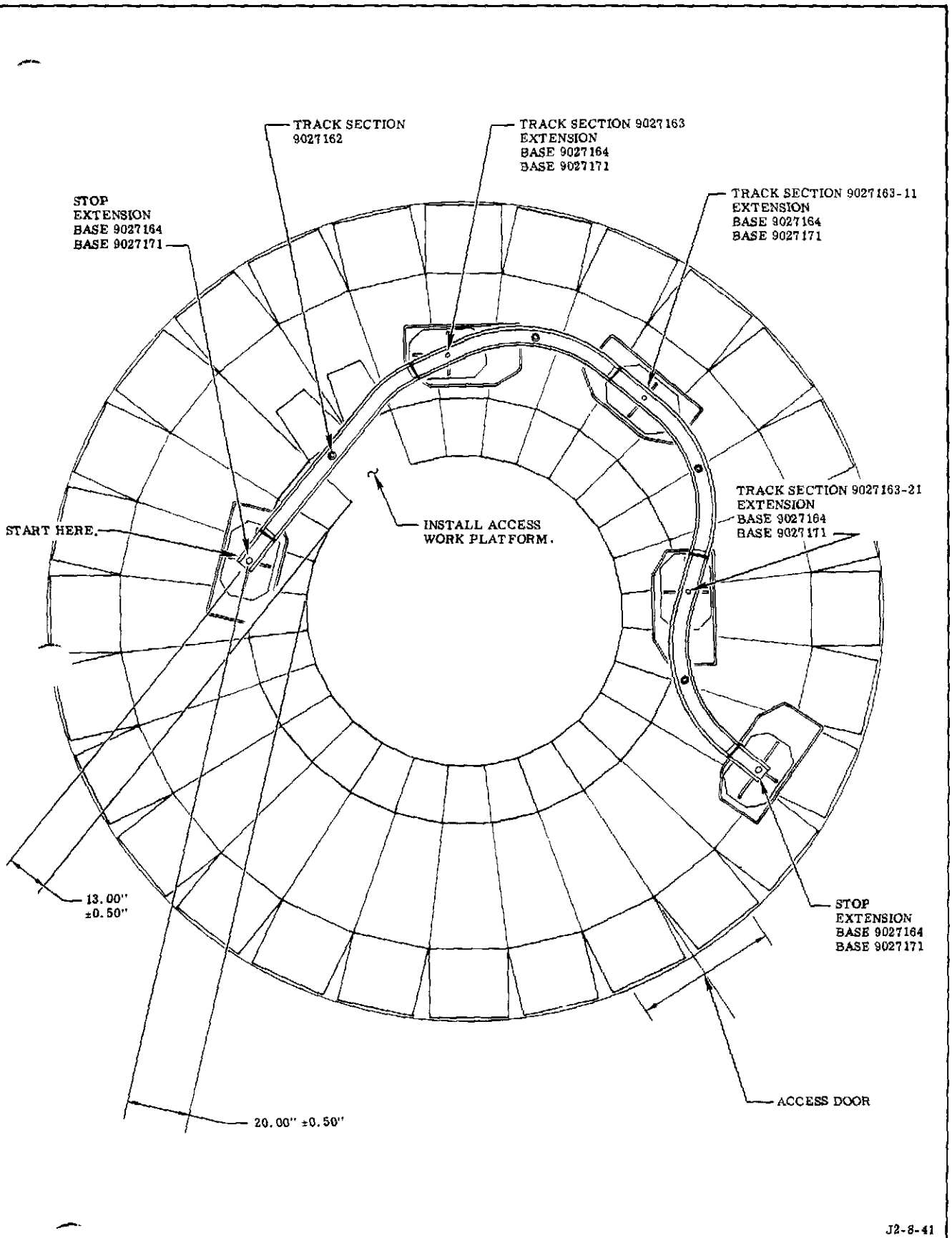

TRACK SECTION 9027162
TRACK SECTION 9027163 EXTENSION BASE 9027164 BASE 9027171
TRACK SECTION 9027163-11 EXTENSION BASE 9027164 BASE 9027171
STOP EXTENSION BASE 9027164 BASE 9027171
TRACK SECTION 9027163-21 EXTENSION BASE 9027164 BASE 9027171
START HERE.
INSTALL ACCESS WORK PLATFORM.
13.00" ±0.50"
STOP EXTENSION BASE 9027164 BASE 9027171
ACCESS DOOR
20.00" ±0.50"
J2-8-41

Figure 2-25. Location of Track Components for Removing Electrical Control Assembly and Fuel High-Pressure Duct (200-Series Stage)

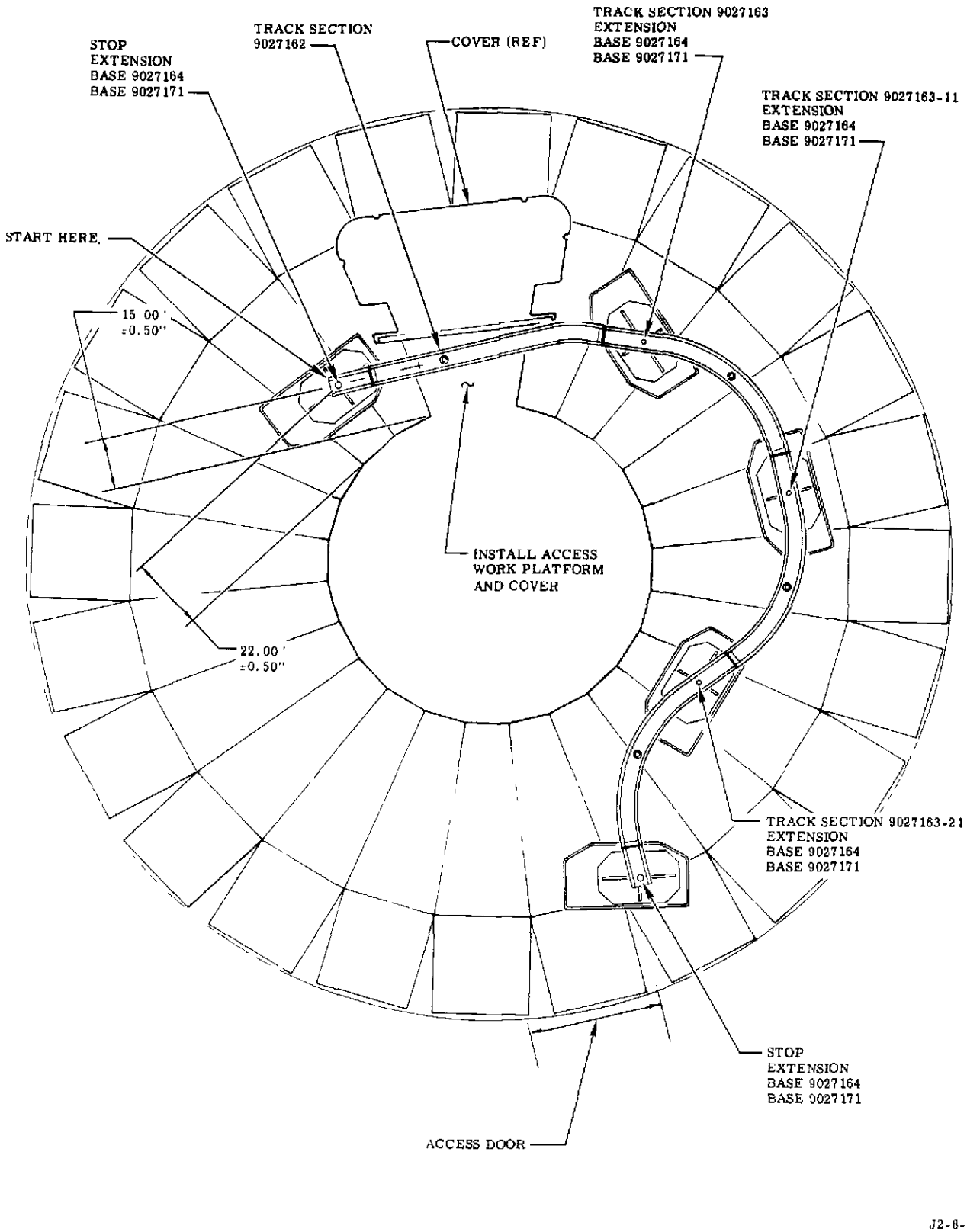


Figure 2-26. Location of Track Components for Removing Electrical Control Assembly and Fuel High-Pressure Duct (500-Series Stage)

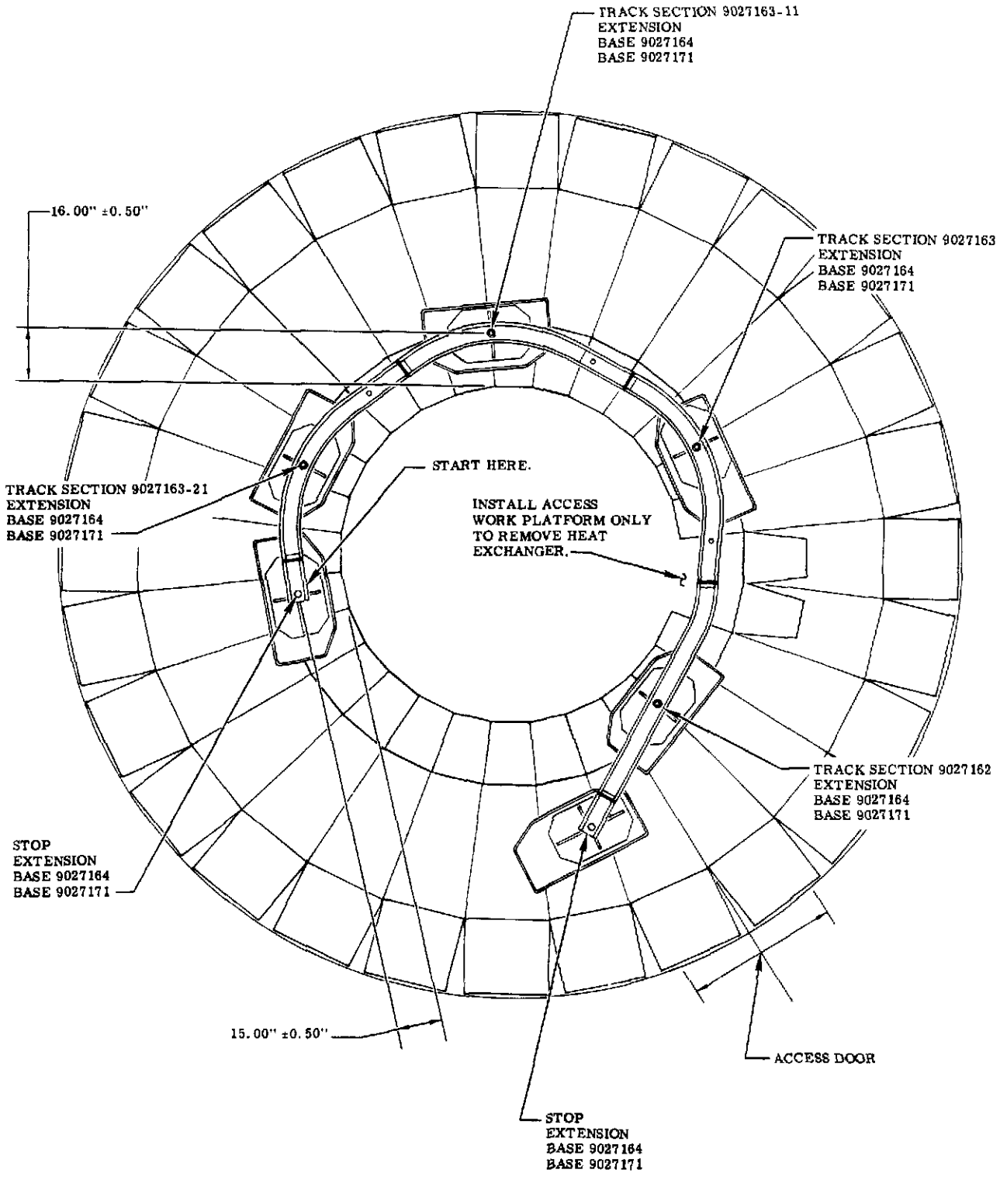


Figure 2-27. Location of Track Components for Removing Fuel Inlet Duct, Gimbal, Heat Exchanger, and Oxidizer Inlet Duct (200-Series Stage)

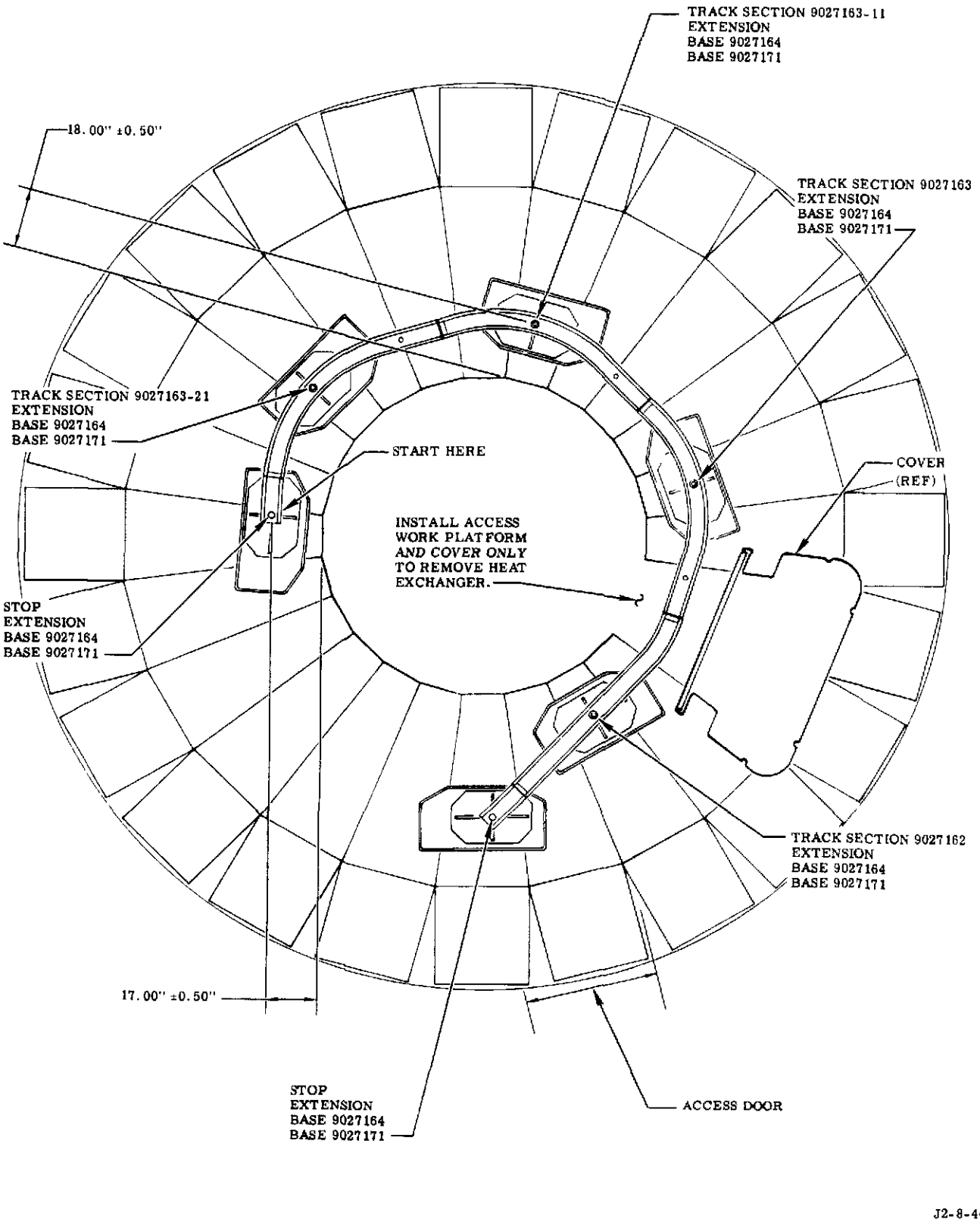


Figure 2-28. Location of Track Components for Removing Fuel Inlet Duct, Gimbal, Heat Exchanger, and Oxidizer Inlet Duct (500-Series Stage)

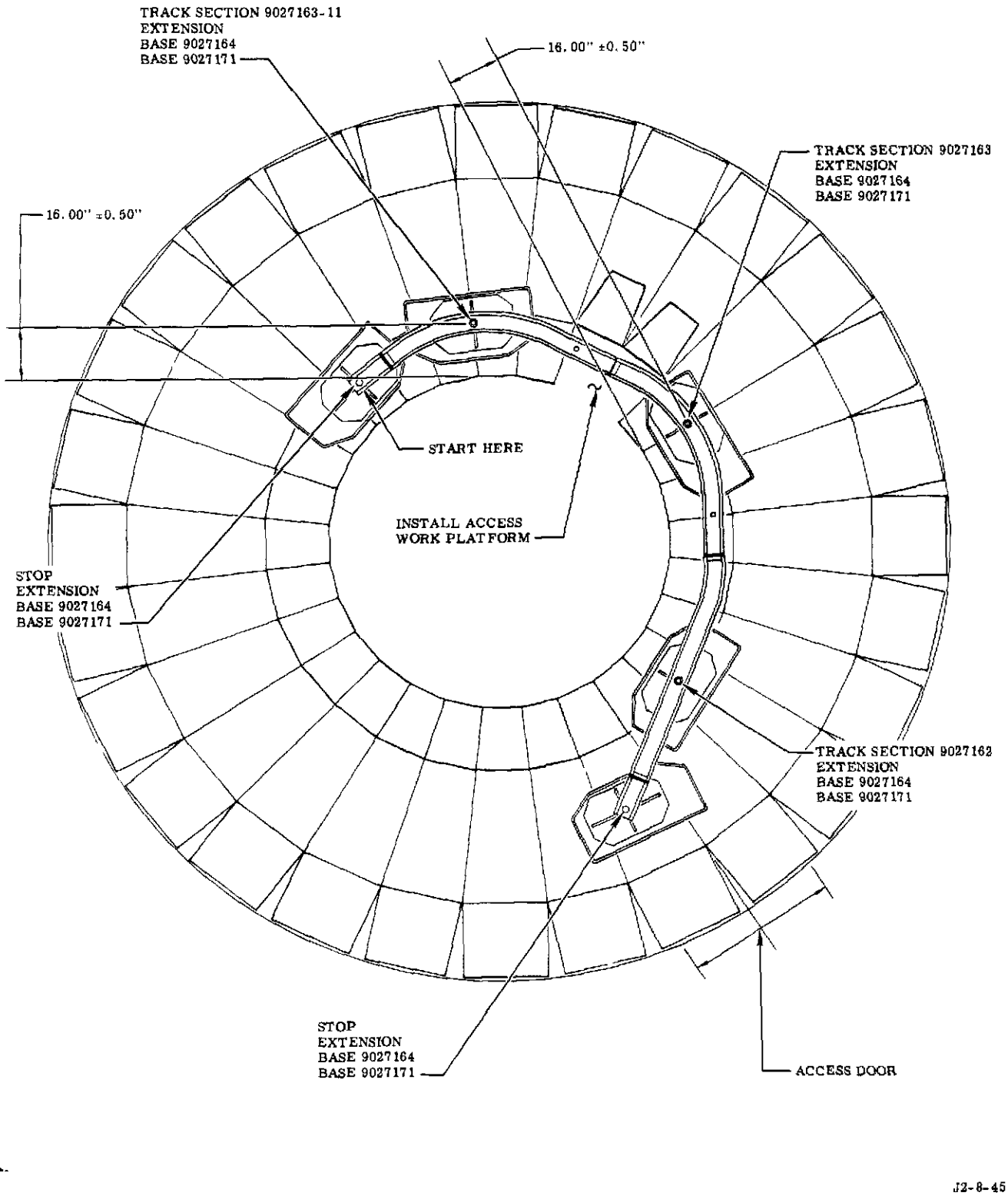


Figure 2-29. Location of Track Components for Removing Oxidizer High-Pressure Duct and Primary Flight Instrumentation Package (200-Series Stage)

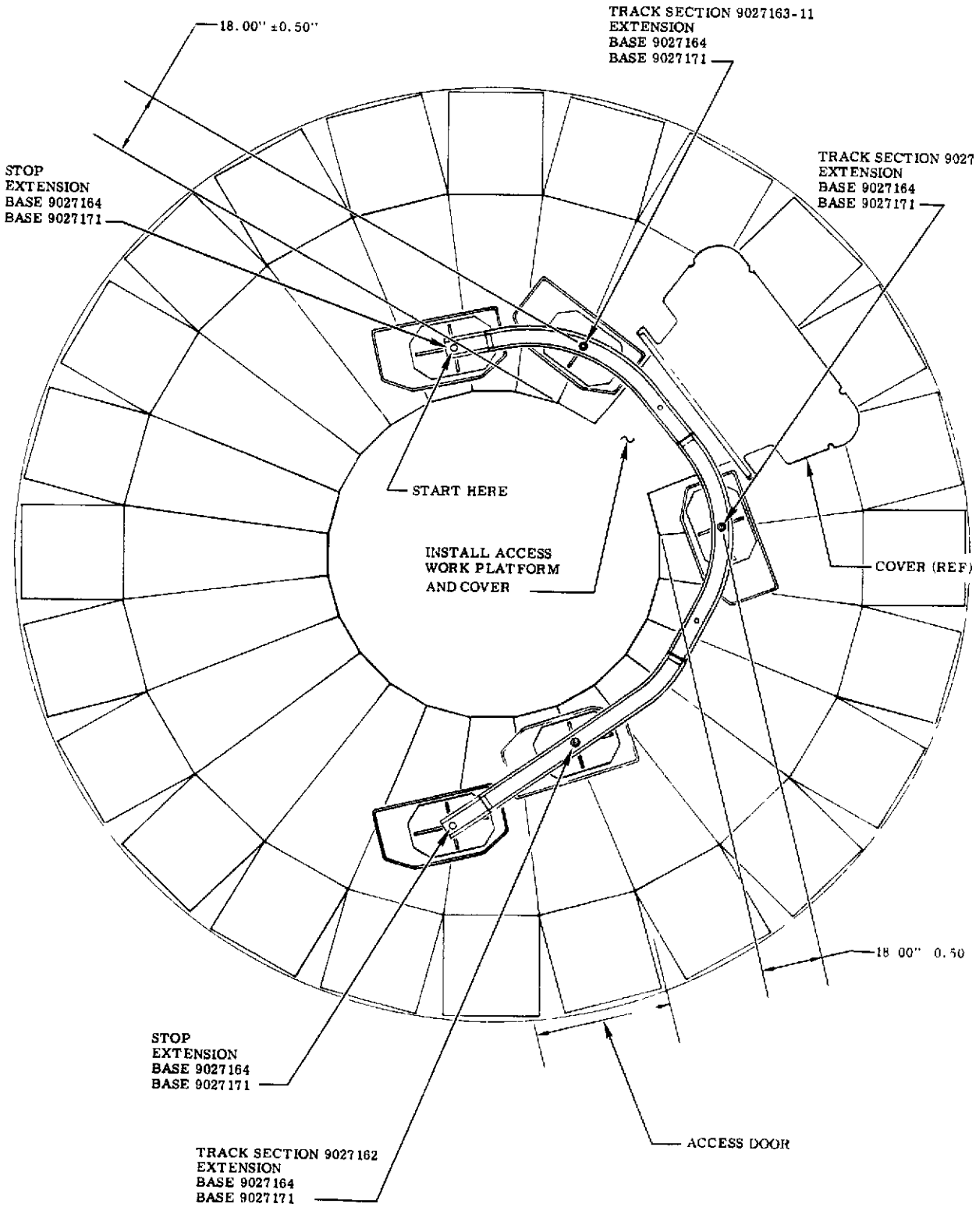


Figure 2-30. Location of Track Components for Removing Oxidizer High-Pressure Duct and Primary Flight Instrumentation Package (500-Series Stage)

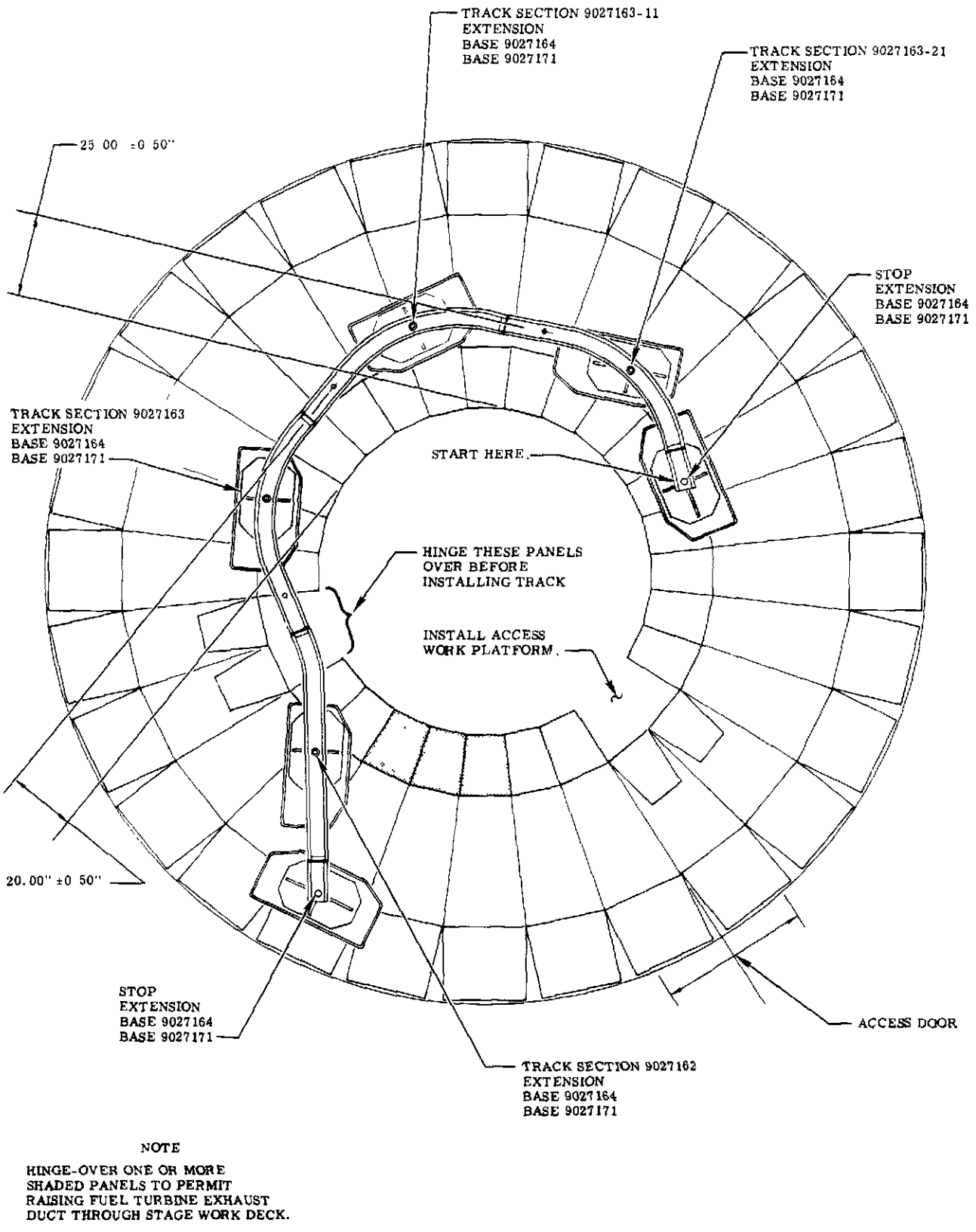


Figure 2-31. Location of Track Components for Removing Turbine Exhaust Duct (200-Series Stage)

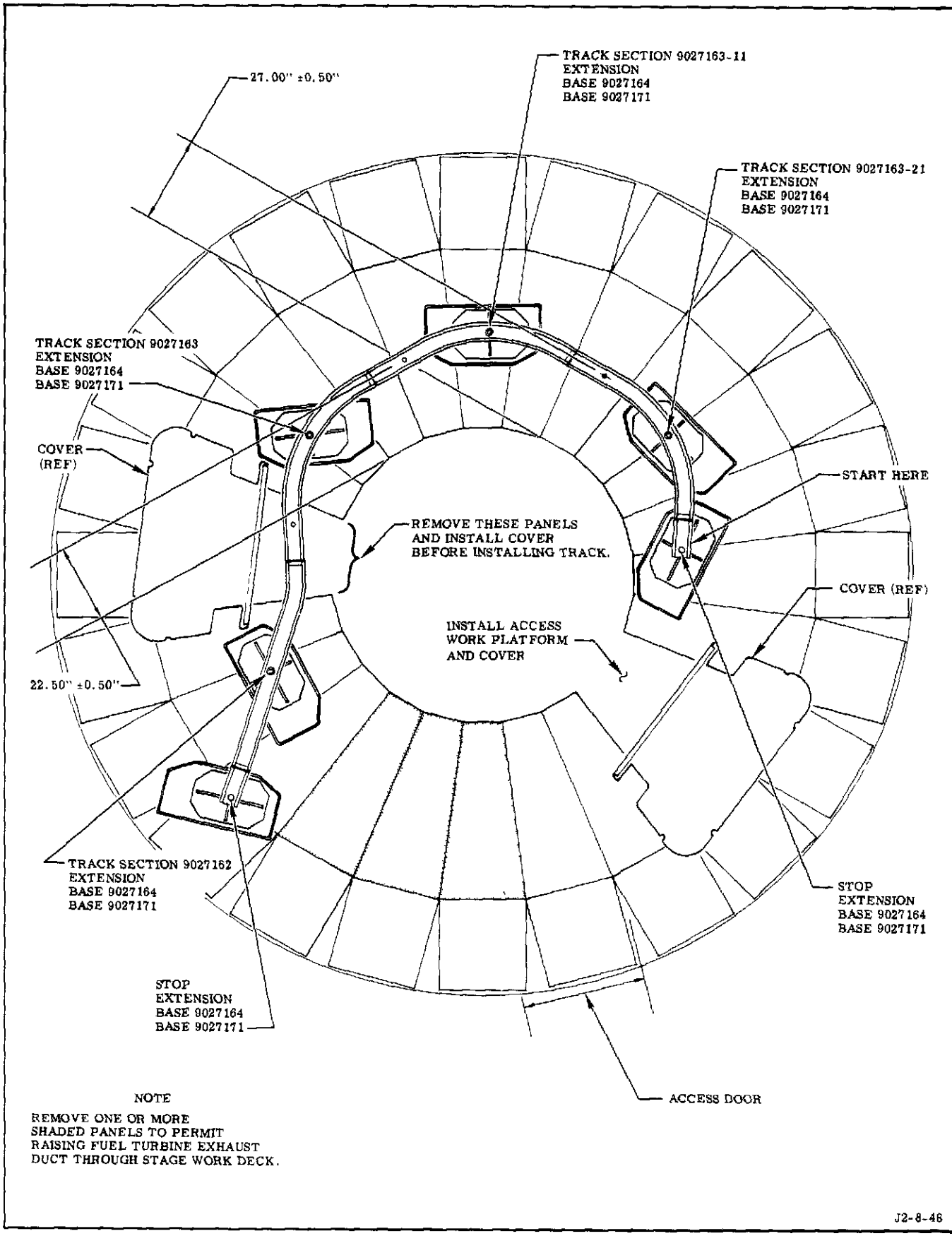


Figure 2-32. Location of Track Components for Removing Turbine Exhaust Duct (500-Series Stage)

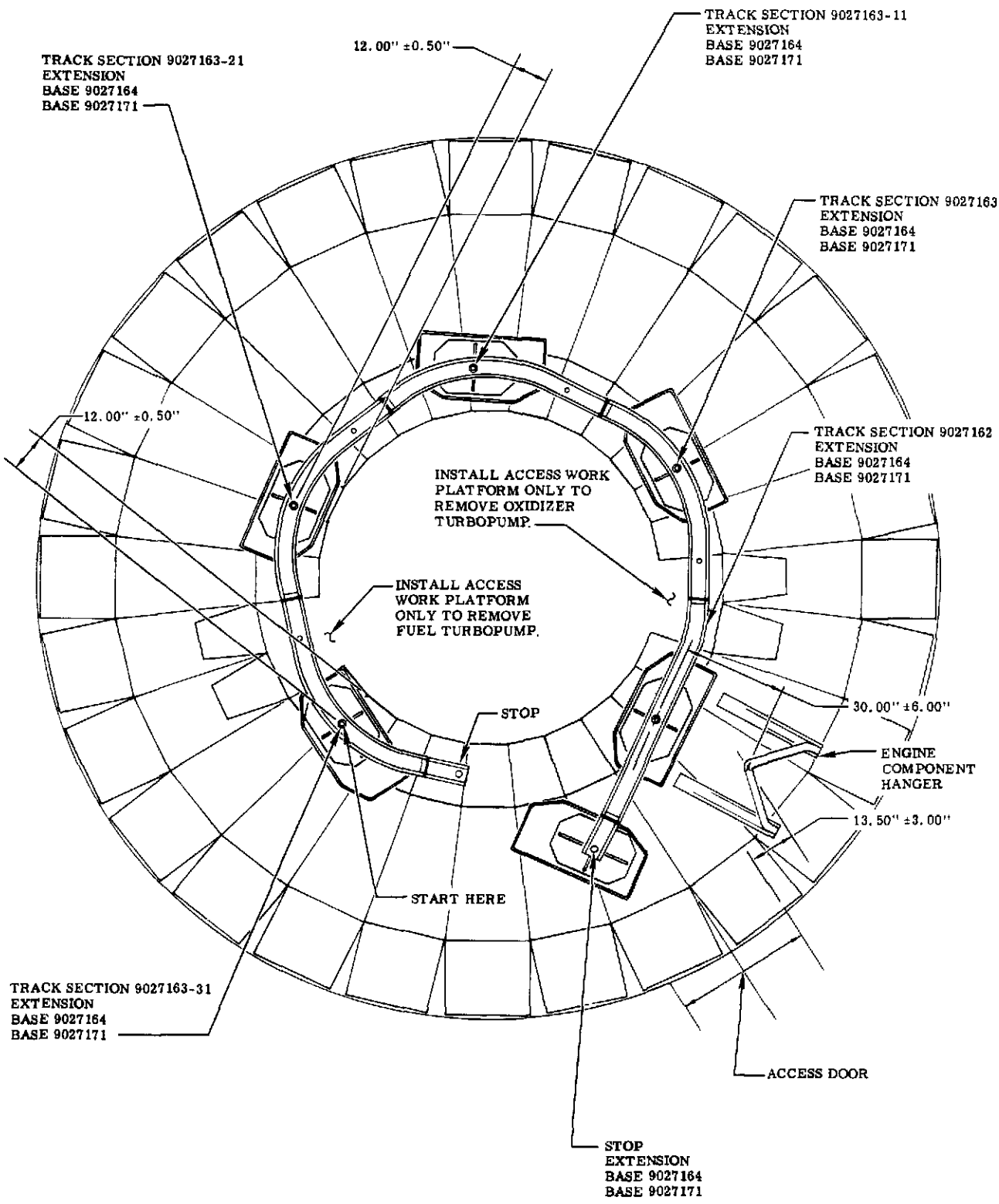


Figure 2-33. Location of Track Components for Removing Thrust Chamber Injector and Oxidizer and Fuel Turbopump (200-Series Stage)

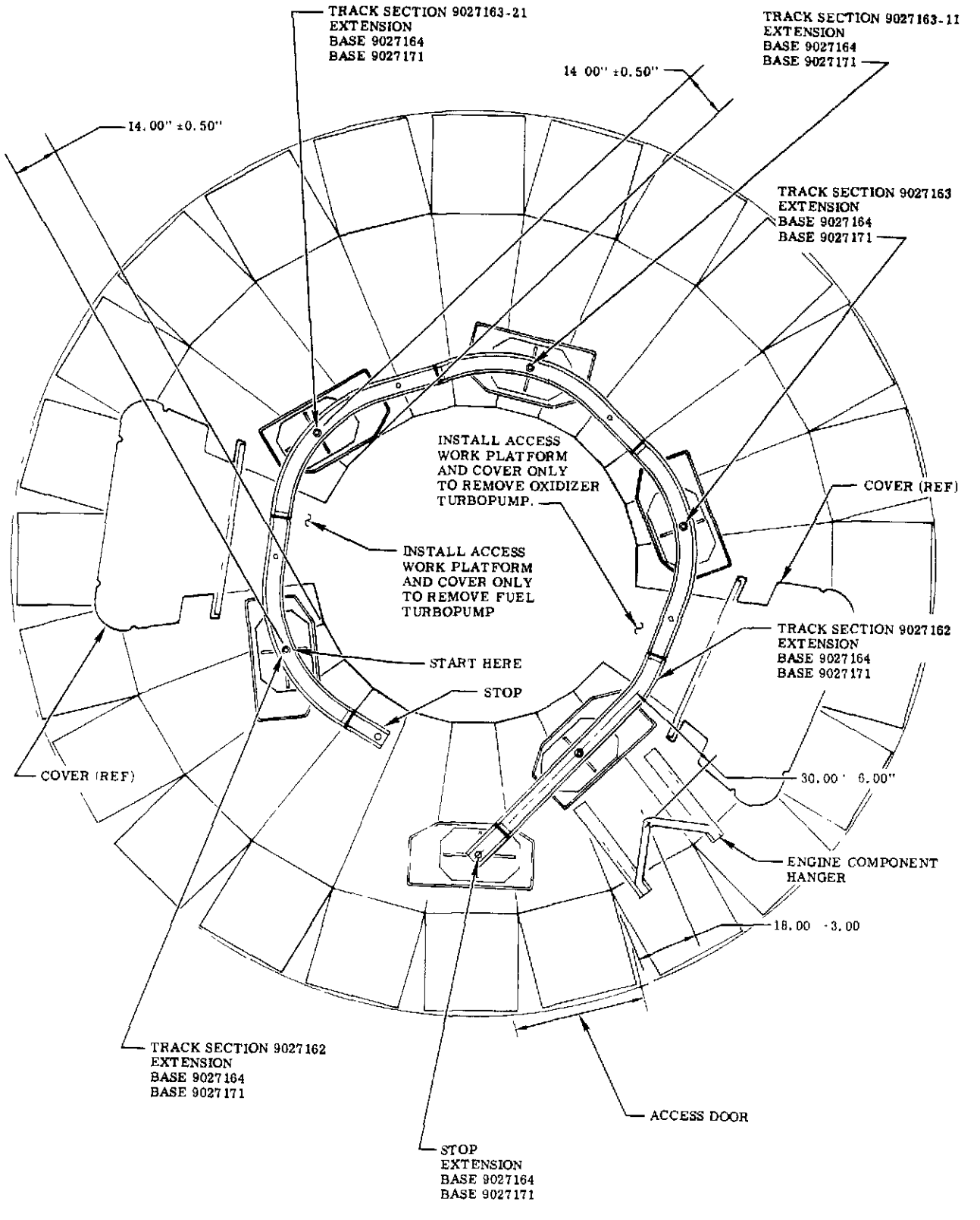


Figure 2-34. Location of Track Components for Removing Thrust Chamber Injector and Oxidizer and Fuel Turbopump (500-Series Stage)

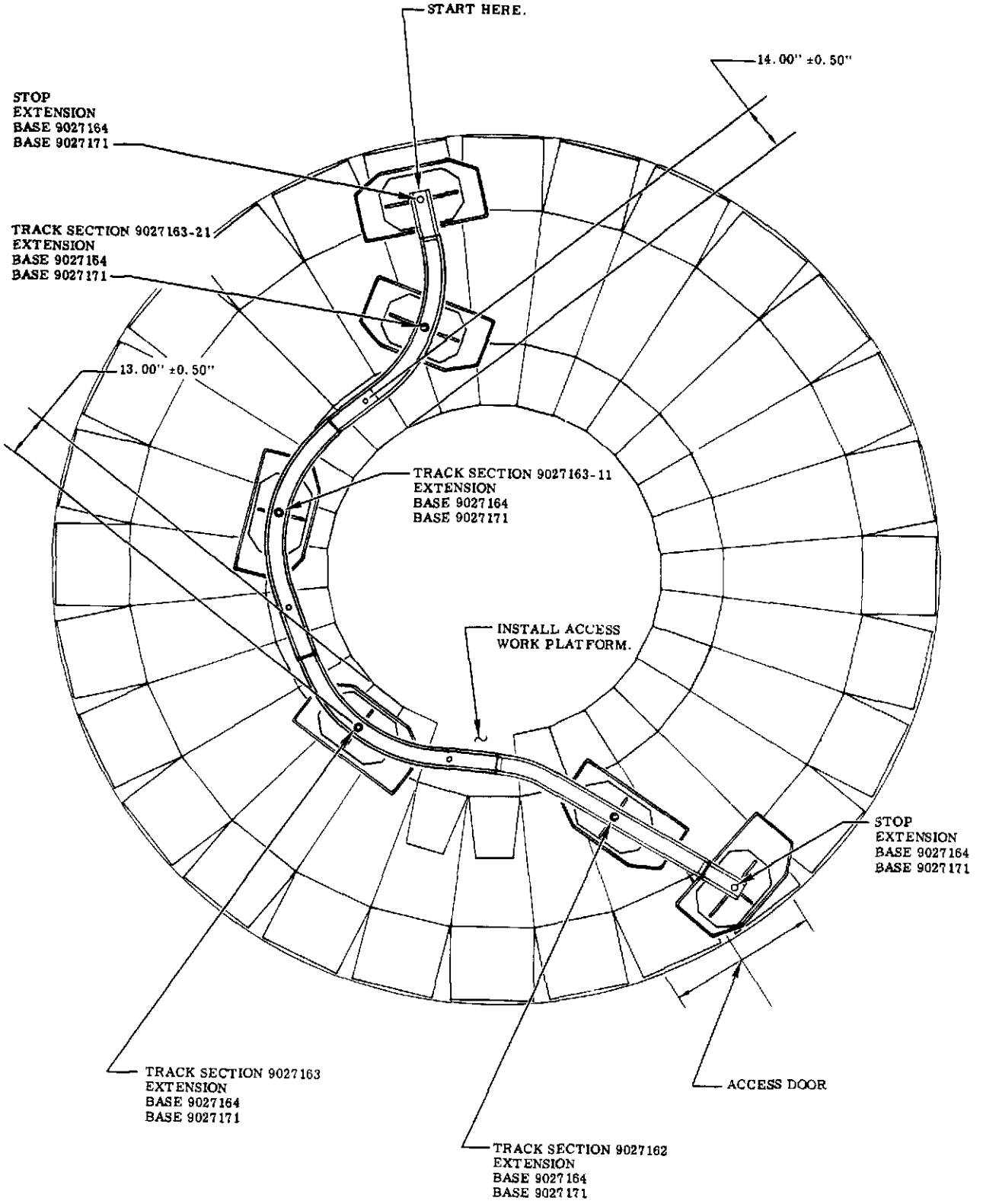


Figure 2-35. Location of Track Components for Removing Integral Hydrogen-Helium Start Tank and Auxiliary Flight Instrumentation Package (200-Series Stage)

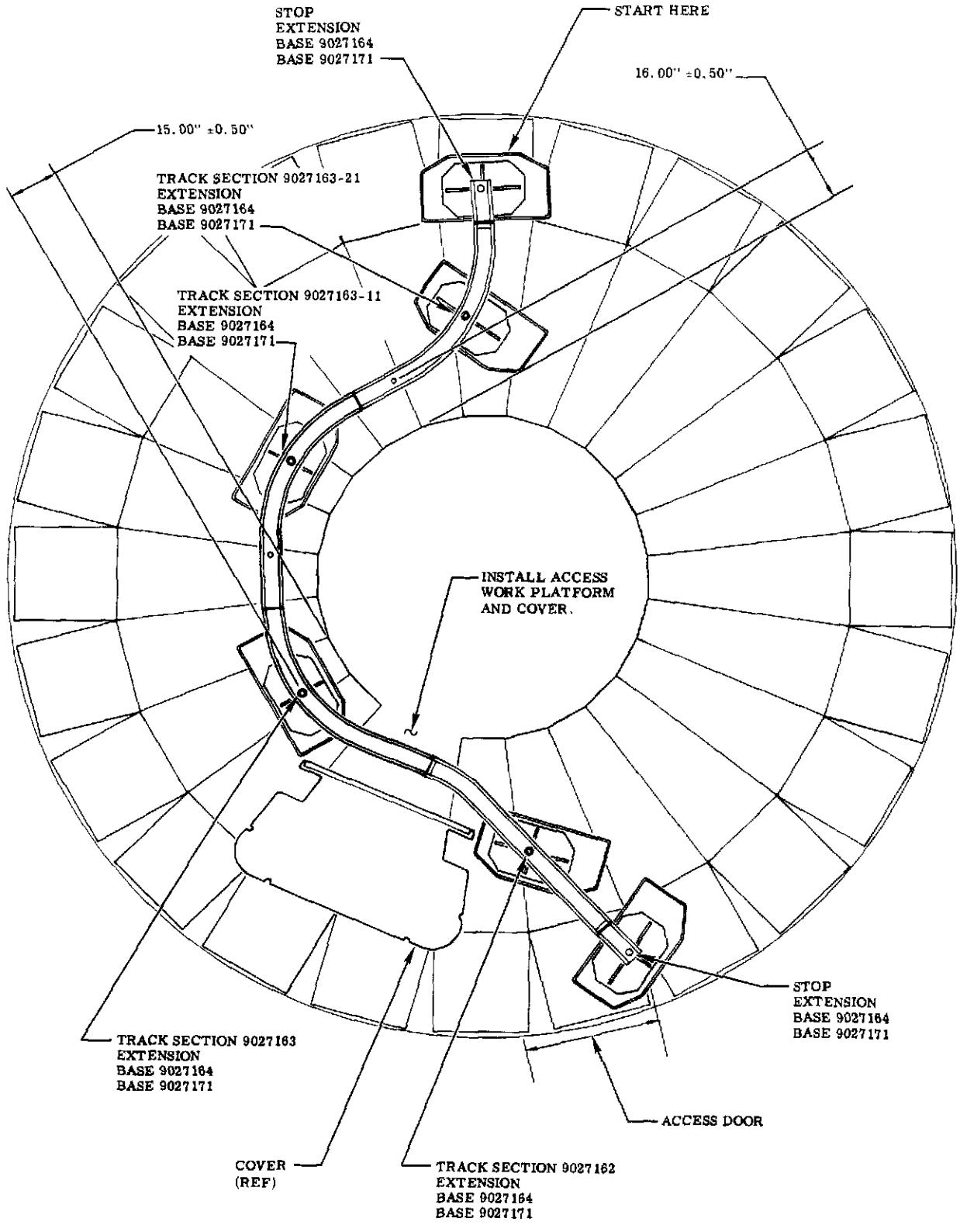


Figure 2-36. Location of Track Components for Removing Integral Hydrogen-Helium Start Tank and Auxiliary Flight Instrumentation Package (500-Series Stage)

Nomenclature	Part Number	Number Required to Install Track Illustrated in Figures				Shelf Number
		2-25, 2-26, 2-31, 2-32	2-27, 2-28	2-33, 2-34	2-29, 2-30, 2-35, 2-36	
Track section	9027162	1	1	1	1	4
Track section	9027163	1	1	1	1	4
Track section	9027163-11	1	1	1	1	4
Track section	9027163-21	1	1	1		4
Track section	9027163-31			1		4
Stop	9027156	2	2	2	2	4
Base	9027164	5	6	6	5	2/3
Turntable	9027101	1	1	1	1	2
Boom	9027051	1	1	1	1	2
Base	9027171	5	6	6	5	1
Extension	9027196	5	6	6	5	1
Support pin	9027161	5	6	6	5	1
Track pin	9027160	5	5	6	4	1

Figure 2-37. Parts Required to Install Tracks Illustrated in Figures 2-25 Through 2-36

k. Install turntable with controls positioned as required by removal procedure. Make sure brake is release (brake handle fully inboard) while installing turntable, and position turntable at or beyond nearest track support before allowing full weight of turntable to be applied to track. If in doubt how to install turntable, see figure 1-5 for an installed view.

l. Install remaining stop in same manner as track sections were installed.

m. Position base plates wherever possible to bear on 3 sections of stage work deck. Position base plates to bear fully on one section and equally on the two adjacent sections. Where base plates cannot be positioned to bear on 3 sections (located outboard where sections are wider) position base plates to bear equally on two sections.

n. Adjust track so that centerline of track is 9-3/8 ±1/4 inches from top of work deck and rolling surfaces of rails are not misalined by more than 0.010 inch. Adjust extensions, as necessary, to aline rail surfaces, maintaining track elevation within required height. If adjustment nuts are difficult to rotate, lubricate threads using Molykote G paste (Dow Corning Corp).

NOTE

Misalinement of track rails exceeding 0.010 inch can cause undesirable shock loads when the loaded hoist moves over the rails and can prevent movement of the hoist if misalinement exceeds wheel-to-track clearance.

o. Install boom on turntable, and handtighten 4 bolts that secure boom to turntable.

p. Install boom adapter if required by removal procedures.

2-20. INSTALLING HEAT SHIELD SUPPORT TURNBUCKLE. Installation of the heat shield support turnbuckle is required when the start tank or fuel turbine exhaust duct is removed or installed on the center engine (engine position 5). Obtain heat shield support turnbuckle 9027185 from compartment on shelf 3 of stowage cart assembly. (Refer to section I.)

a. Between engine positions 2 and 3, adjacent to V-strut (stage), determine distance (to nearest 1/32 inch) between top surfaces of platform 9027190 and heat shield (stage). Dimension is 10-1/2 ±1/8 inches. (See figure 2-38.)

WARNING

Applying weight to the heat shield with the V-strut or support turnbuckle disconnected can result in damage to equipment and injury to personnel.

b. Remove heat shield V-strut (stage) in accordance with applicable stage procedures, and install support turnbuckle (figure 2-38). Make sure no weight is applied to heat shield between the time V-strut is disconnected and support strut is installed.

c. Adjust support turnbuckle to properly position heat shield. (Refer to step a.)

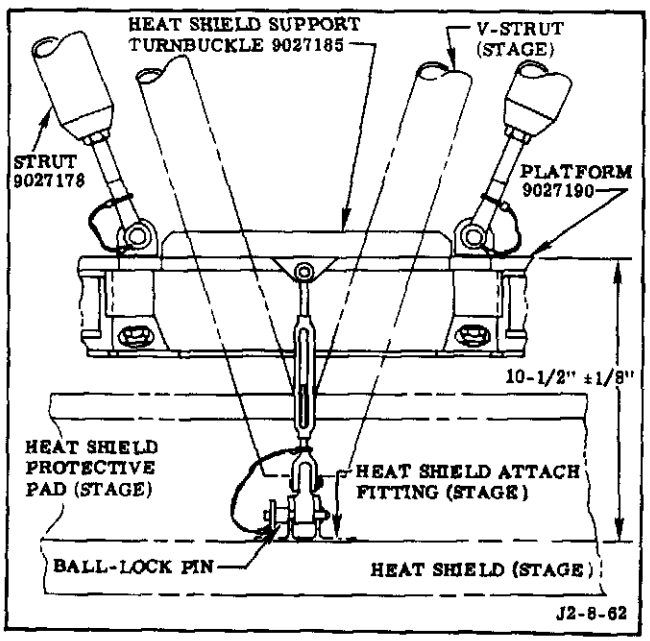


Figure 2-38. Installing Heat Shield Support Turnbuckle

2-21. REMOVING TRACK AND HOIST. Remove track and hoist in reverse order of installation except as follows:

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

- The track sections must be supported at all times during removal, to prevent damage to equipment and injury to personnel.

a. If track sections cannot be separated manually, insert a 1/2-inch-diameter rod, as a handhold, in the 17/32-inch-diameter horizontal hole in ends of track sections nearest joint, and pry track sections apart using wedge-shaped slot at track joint.

b. Place and secure all track and hoist parts in stowage cart assembly. (Refer to paragraph 2-4.)

2-22. REMOVING HEAT SHIELD SUPPORT TURNBUCKLE. Remove support turnbuckle in reverse order of installation except as follows:

WARNING

Applying weight to the heat shield with the V-strut (stage) or support turnbuckle disconnected can result in damage to equipment and injury to personnel.

a. Remove support turnbuckle and install heat shield V-strut in accordance with applicable stage procedures. Make sure no weight is applied to heat shield between the time support turnbuckle is removed and V-strut is installed. (See figure 2-38.)

2-23. ENGINE LOWERING SYSTEM.

2-24. The lowering system lowers the engine a maximum of 7 inches for removal of the thrust chamber injector and/or gimbal. The system consists of frames, beams, and brackets for attachment to stage structure, brackets for

attachment to the engine GSE mounting pads, d turnbuckles for interconnecting the two. The frames and beams are required for engine positions 1 through 4 only.

2-25. INSTALLING ENGINE LOWERING SYSTEM (SII STAGE, ENGINE POSITIONS 1 THROUGH 4). This procedures provides information for installing the lowering system and connecting it to the engine. Alinement of the lowering system and engine lowering procedures are found in the removal procedures for the component requiring this task. When installed, the lowering system appears as shown in figure 2-39.

a. Obtain Engine Components Installer G4071 parts listed in figure 2-40. Make sure turnbuckle 9027226-11 is prepared for use. Turnbuckle must have adjustment mechanism and link installed. If in doubt whether turnbuckle is prepared, refer to paragraph 2-28. (Refer to paragraph 2-4 for information on unloading stowage cart.)

b. Obtain the following special tools and materials:

(1) Torque wrench, 100-750 inch-pounds.

(2) Closures RX20621-21, or equivalent (2 required)

(3) Fasteners (bolts, nuts, and washers), as required, to install RX-closures

(4) Twelve Fist Grip Clips G429-1/4 (Crosby-Laughlin), or equivalent

(5) Two 16-18 foot lengths of 1/4-inch cable. Cable must be 6x19 or 7x19 galvanized or stainless steel with a minimum breaking strength of 6,000 pounds.

c. Remove hydraulic actuators from engine in accordance with applicable stage procedures.

d. Remove oxidizer and fuel inlet ducts Refer to section III for procedures.

e. Disconnect HYDROGEN TANK PRESSURIZATION hose from flange at thrust chamber. Remove seal. Install closure RX20621-21 (or equivalent) on each flange. Closures must be certified clean for propellant system use.

f. Move disconnected end of HYDROGEN TANK PRESSURIZATION hose over fluid interface lines (toward start tank), and secure hose to fluid interface lines.

g. Attach bracket 9027232 to GSE mounting pad on oxidizer side of engine (figure 2-41).

h. Attach bracket 9027231 to GSE mounting pad on fuel side of engine with 4 captive bolts. Torque bolts to 330-430 inch-pounds.

i Install bracket 9027248 (figure 2-42). Frames shown in illustration are installed in next step.

j. Install frames 9027249-11 and 9027249-12 by attaching short arm of frames to hydraulic actuator upper attach brackets and frames to bracket 9027248 as shown in figure 2-42. If attached ball-lock pins cannot be used to secure frames to hydraulic actuator upper attach bracket (due to interference with stage structure), stage hydraulic actuator attach pins or suitable equivalents may be substituted.

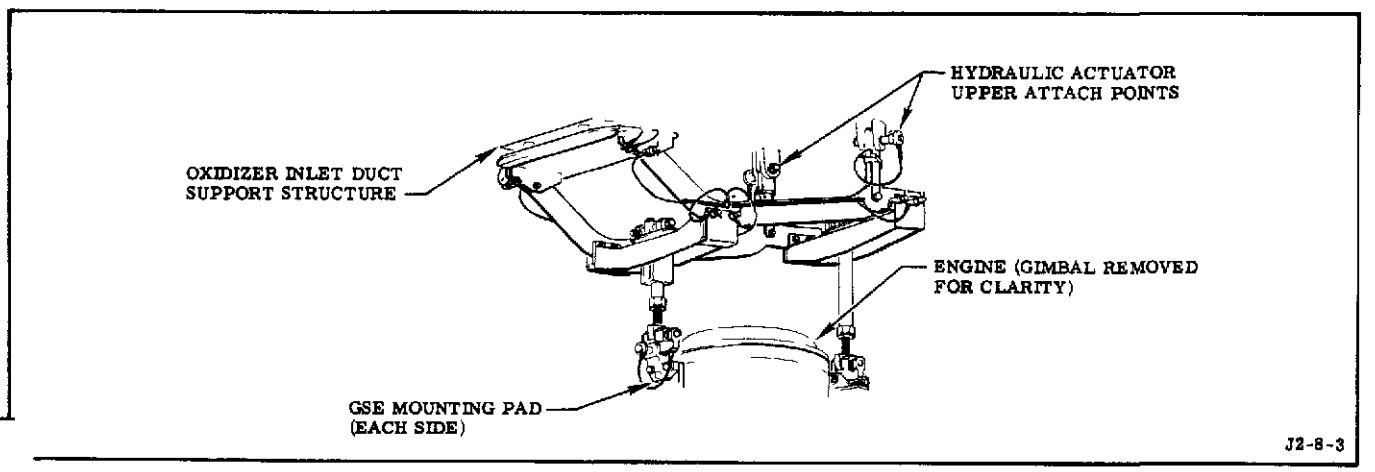

HYDRAULIC ACTUATOR UPPER ATTACH POINTS
OXIDIZER INLET DUCT SUPPORT STRUCTURE
ENGINE (GIMBAL REMOVED FOR CLARITY)
GSE MOUNTING PAD (EACH SIDE)
J2-8-3

Figure 2-39. Lowering System Installed (Engine Positions 1 Through 4)

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number
Turnbuckle[a]	9027226-1		2
Bracket[a]	9027232		2
Turnbuckle	9027226-11		3
Bracket[b]	9027231		2
Bolts[c]	9027227	4	2
Frame	9027249-11		2
Frame	9027249-12		2
Bracket	9027248		2
Beam	9027258-1		2
Beam	9027258-11		2

(a) Stored assembled
(b) Stored assembled on either turnbuckle 9027226-2 (shelf 2) or turnbuckle 9027226-11 (shelf 3)
(c) Captive in bracket 9027231

Figure 2-40. G4071 Parts Required to Install Lowering System (Engine Positions 1 Through 4)

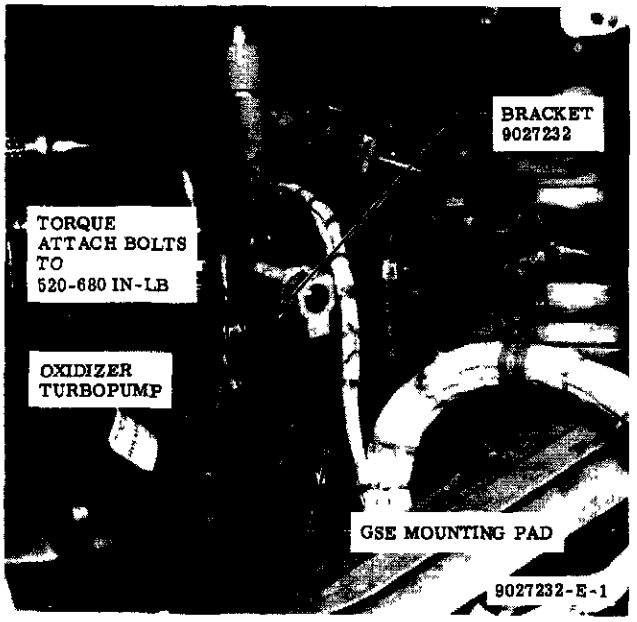


Figure 2-41. Bracket Installed (Oxidizer Side)

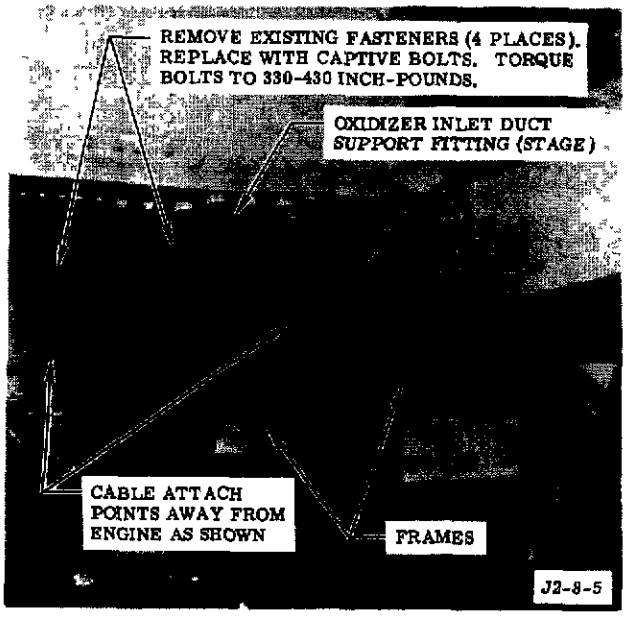

REMOVE EXISTING FASTENERS (4 PLACES). REPLACE WITH CAPTIVE BOLTS. TORQUE BOLTS TO 330-430 INCH-POUNDS.
OXIDIZER INLET DUCT SUPPORT FITTING (STAGE)
CABLE ATTACH POINTS AWAY FROM ENGINE AS SHOWN
FRAMES
J2-8-5

Figure 2-42. Bracket 9027248 Installed

WARNING

Missing roll pins can allow the turnbuckle to be extended beyond safe limits, causing damage to equipment and injury to personnel.

k. On the longer of the 2 turnbuckles, roll back rubber sleeve and make sure that roll pins are installed (figure 2-43). On the shorter turnbuckle, make sure that 2 roll pins are installed in threaded portions. One roll pin is visible on external surfaces of turnbuckle, and second roll pin is visible (when turnbuckle is extended) through 1/4-inch hole in lower portion of turnbuckle. Turnbuckles must not be used without roll pins installed. Replace rubber sleeve over slot on longer turnbuckle.

l. Adjust lower end of both turnbuckles to position shown in figure 2-44. This permits passage through limited access hole in beams.

m. Adjust shorter turnbuckle to its maximum extended length (roll pins prevent further extension); then shorten turnbuckle to 1/2 half or less of its extendable length, making sure that ends of turnbuckle do not rotate, so that takeup is distributed evenly between the 2 threaded portions.

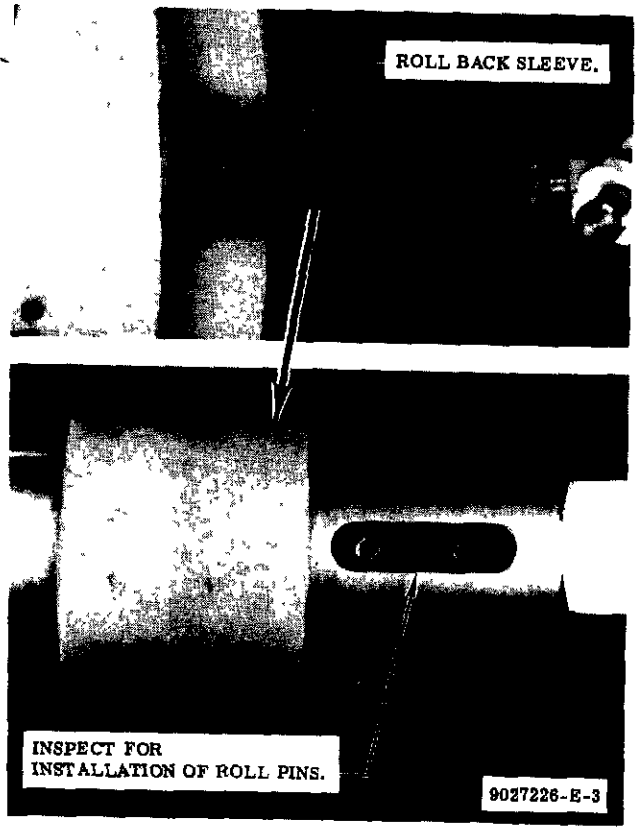


Figure 2-43. Inspecting for Roll-Pin Installation

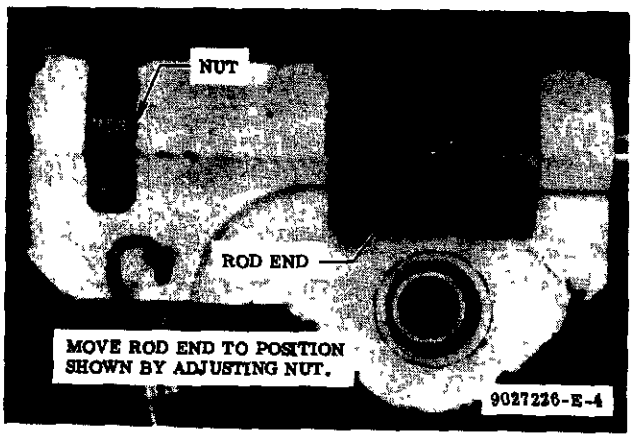


Figure 2-44. Adjusting Turnbuckle Prior to Installation

n. Attach turnbuckle 9027226-11 to beam 9027258-11 by inserting lower end of turnbuckle through beam (figure 2-45) and engaging upper adjusting mechanism to studs in beam.

Install turnbuckle and beam to frames on oxidizer side of engine. (See figure 2-46.)

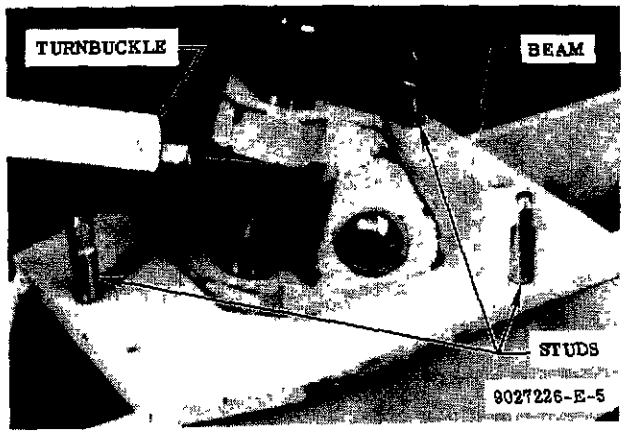


Figure 2-45. Inserting Turnbuckle Through Beam

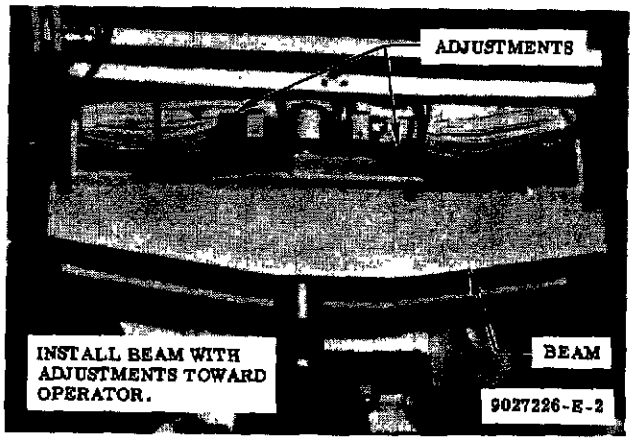


Figure 2-46. Beam Assembled to Frames

p. Adjust turnbuckle length, making sure equal distribution of threaded engagement is not disturbed, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

q. Adjust lower end of turnbuckle to dimension shown in figure 3-26.

r. Shorten turnbuckle to take up slack.

s. Attach turnbuckle 9027226-1 to beam 9027258-1 and install turnbuckle and beam to frames, in same manner as previous assembly, except install on fuel side of engine. Adjustment at top of turnbuckle must be toward operator. (See figure 2-46.)

t. Make sure same number of threads (within one thread) show at each end of turnbuckle. Adjust if necessary.

u. Adjust turnbuckle length, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

v. Adjust lower end of turnbuckle to dimension shown in figure 3-26.

w. Shorten turnbuckle to take up slack.

x. Inspect installation. All ball-lock pins must be fully engaged, and bolts that secure brackets to oxidizer inlet support structure and thrust chamber must be seated and torqued.

y. Install cables as shown in figure 2-47 (SII-stage outboard engines). Adjust effective length of cables so that total slack will permit required lowering of engine, plus a maximum of 2 inches. However, under no condition is total slack to exceed 7 inches.

2-26. INSTALLING ENGINE LOWERING SYSTEM (SII STAGE, ENGINE POSITION 5). This procedures provides information for installing the lowering system and connecting it to the engine. Alinement of lowering system to engine cg and engine lowering procedures are found in the removal procedures for the component requiring this task. When installed, the lowering system appears as shown in figure 2-48.

a. Obtain Engine Components Installer G4071 parts listed in figure 2-49. Make sure turnbuckle 9027226-2 is prepared for use. Turnbuckle must have adjustment mechanism and link installed. If in doubt whether turnbuckle is prepared, refer to paragraph 2-28. (Refer to paragraph 2-4 for information on unloading stowage cart.)

b. Obtain a 100-750 inch-pound torque wrench, 12 Fist Grip Clips G-429-1/4 (Crosby-Laughlin), or equivalent, and two 16-18 foot lengths of 1/4-inch cable. Cable must be 6x19 or 7x19 galvanized or stainless steel with a minimum breaking strength of 6,000 pounds.

c. Attach bracket 9027232 to GSE mounting pad on oxidizer side of engine (figure 2-41).

d. Attach bracket 9027231 to GSE mounting pad on fuel side of engine with 4 captive bolts. Torque to 330-430 inch-pounds.

WARNING

Missing roll pins can allow the turnbuckle to be extended beyond safe limits, causing damage to equipment and injury to personnel.

e. Roll back rubber sleeve on each turnbuckle and check that roll pins are installed (figure 2-43). Turnbuckles must not be used without roll pins installed. Replace rubber sleeves over slots.

f. Adjust lower end of both turnbuckles to position shown in figure 2-44. This permits passage through limited access hole in brackets.

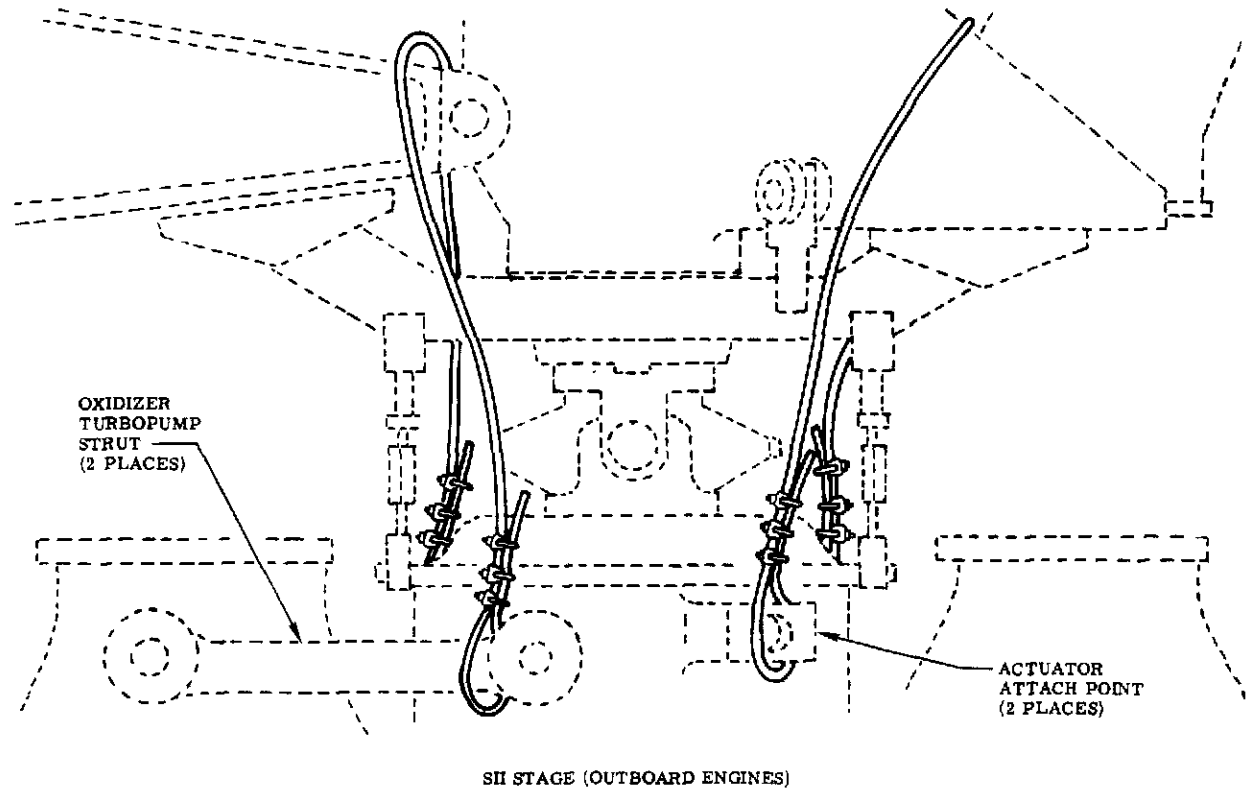
g. Make sure same number of threads (within one thread) show at each end of both turnbuckles. Adjust if necessary.

h. Install bracket 9027259-1 as follows: Pass bracket between fuel inlet duct and web of fin on either side of duct. Rest bracket on lower flange. Make sure bracket is inboard as far as it will go, and lying flat on flange with countersunk areas straddling flange bolts. (See figure 2-50.)

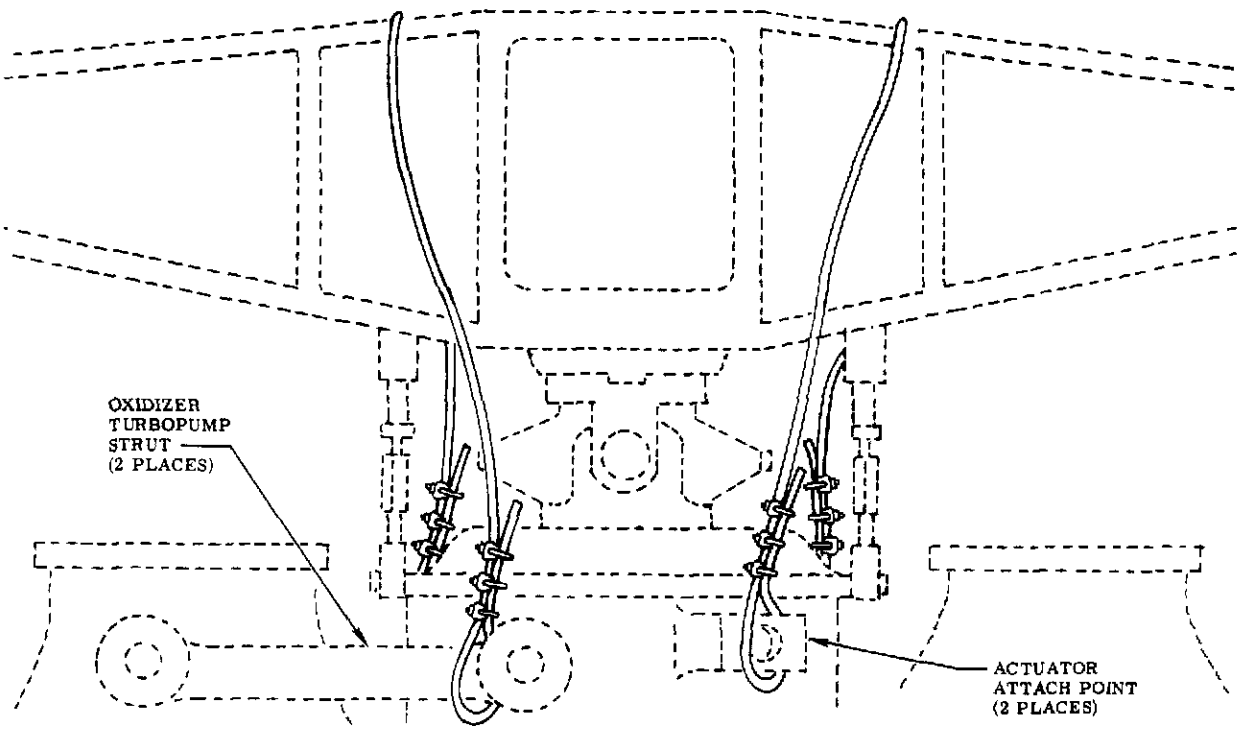
i. Secure bracket to flange by rotating clamping plates under flange and tightening clamp bolts. Do not exceed 155 inch-pounds on clamp bolts.

j. Install turnbuckle 9027226-1 by passing it between fuel inlet duct and web of fin (figure 2-51) on either side of duct. Pass lower end of turnbuckle through bracket (figure 2-52) and engage studs on bracket. Installation will be simplified if turnbuckle is extended one-half or more of its extendable length before installation.

k. Adjust turnbuckle length, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber.

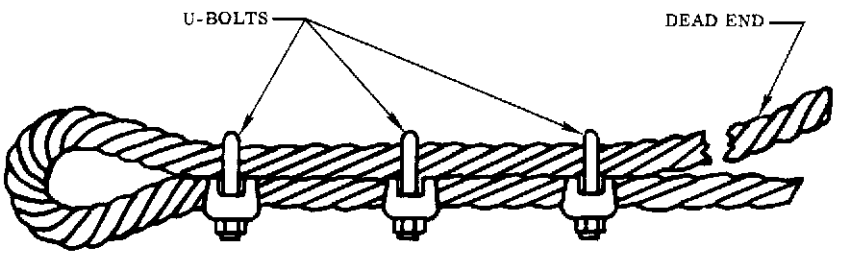


SII STAGE (OUTBOARD ENGINES)



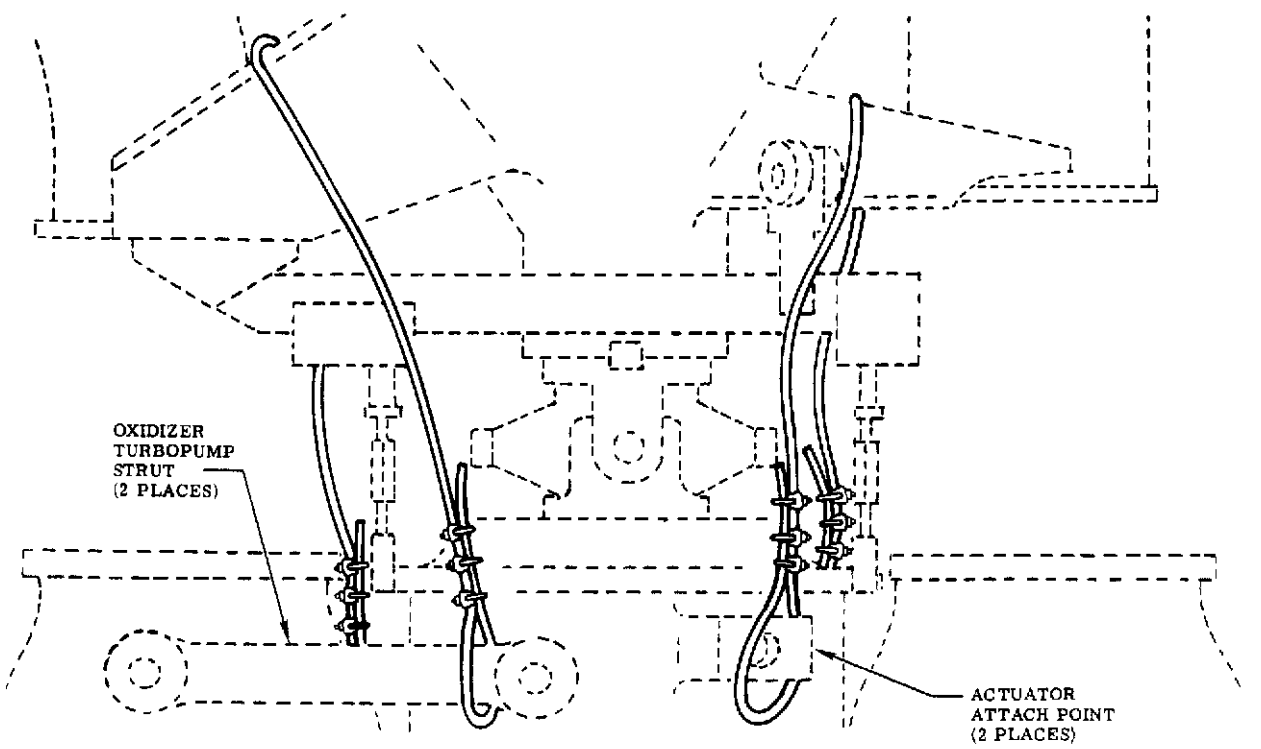
SII STAGE (CENTER ENGINE)

Figure 2-47. Installation of Safety Cables (Sheet 1 of 2)



1. INSTALL ALL CLIPS WITH U-BOLTS ON SHORT (DEAD) END OF CABLE.
2. SPACE CLIPS ON MINIMUM 1-1/2 INCH CENTERS.
3. TORQUE CLIP FURTHEST FROM LOOP TO 25-30 IN-LB. APPLY TORQUE INCREMENTALLY, KEEPING THREAD TAKEUP UNIFORM.
4. APPLY TENSION TO CABLE, AND WHILE CABLE IS UNDER TENSION, TORQUE (REFER TO STEP 3) REMAINING TWO CLIPS

INSTALLATION OF CROSBY CLIPS



SIVB STAGE

J2-8-65

Figure 2-47. Installation of Safety Cables (Sheet 2 of 2)

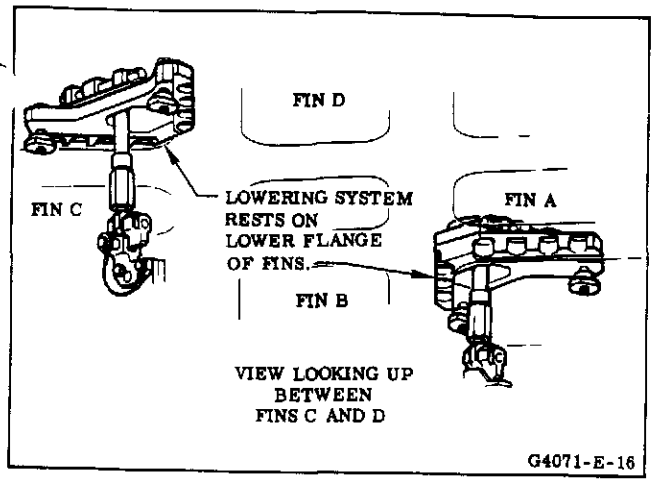


Figure 2-48. Lowering System Installed (Engine Position 5)

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number
Turnbuckle(a)	9027226-1		2
Bracket(a)	9027232		2
Turnbuckle(a)	9027226-2		2
Bracket(b)	9027231		2
olts(b)	9027227	4	2
Bracket	9027259-1		2
Bracket	9027259-2		2

(a) Stored assembled
(b) Captive in bracket 9027231

Figure 2-49. G4071 Parts Required to Install Lowering System (Engine Position 5)

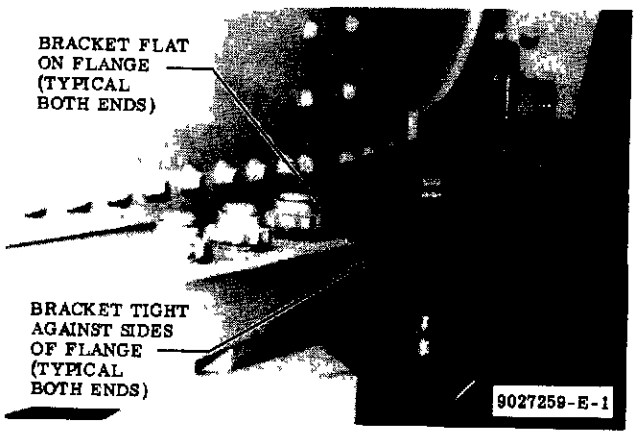


Figure 2-50. Bracket Installed (Fuel Side)

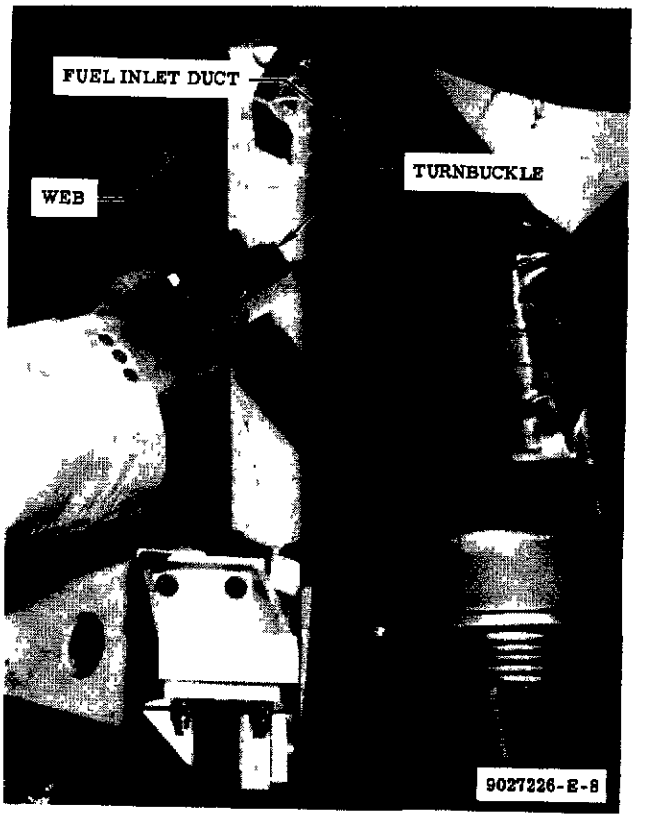


Figure 2-51. Installing Turnbuckle

Figure 2-52. Assembling Turnbuckle to Bracket

l. Adjust lower end of turnbuckle to dimension shown in figure 3-26.

m. Shorten turnbuckle to take up slack.

n. Inspect installation. Bracket must be firmly seated and clamped to flanges, turnbuckle must be engaged to bracket studs, ball-lock pin must be fully engaged, and bolts securing bracket to thrust chamber must be seated and torqued.

o. Install bracket 9027259-2 on lower flange of fins on oxidizer side of engine in same manner 9027259-1 bracket was installed.

p. On turnbuckle 9027226-2, remove bolt and separate turnbuckle from upper adjusting mechanism. (See figure 2-53.) Space limitations prevent installation of the assembled turnbuckle.

q. Install disassembled turnbuckle by passing it between oxidizer inlet duct and web of fin on either side of duct, passing lower end through bracket (see figure 2-52), and engaging upper adjusting mechanism to pins on bracket.

r. Assemble turnbuckle by reinstalling and tightening bolt removed in step o. Do not exceed 155 inch-pounds on bolt.

s. Adjust turnbuckle length, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

t. Adjust lower end of turnbuckle to dimension shown in figure 3-26.

u. Shorten turnbuckle to take up slack.

v. Inspect installation. Bracket must be firmly seated and clamped to flanges, turnbuckle must be engaged to pins of bracket, ball-lock pin must be fully engaged, and bolts that secure bracket to thrust chamber must be seated and torqued.

w. Disconnect and remove stage stiff arms from engine in accordance with applicable stage procedures.

x. Install cables as shown in figure 2-47 (SII-stage center engine). Adjust effective length of cables so that total slack will permit required lowering of engine, plus a maximum of 2 inches. However, under no condition is total slack to exceed 7 inches.

2-27. *INSTALLING ENGINE LOWERING SYSTEM (SIVB STAGE).* This procedures provides information for installing the lowering system and connecting it to the engine. Engine lowering procedures are found in the removal procedures for the component requiring this task. When installed, the lowering system appears as shown in figure 2-54.

a. Obtain Engine Components Installer G4072 parts listed in figure 2-55.

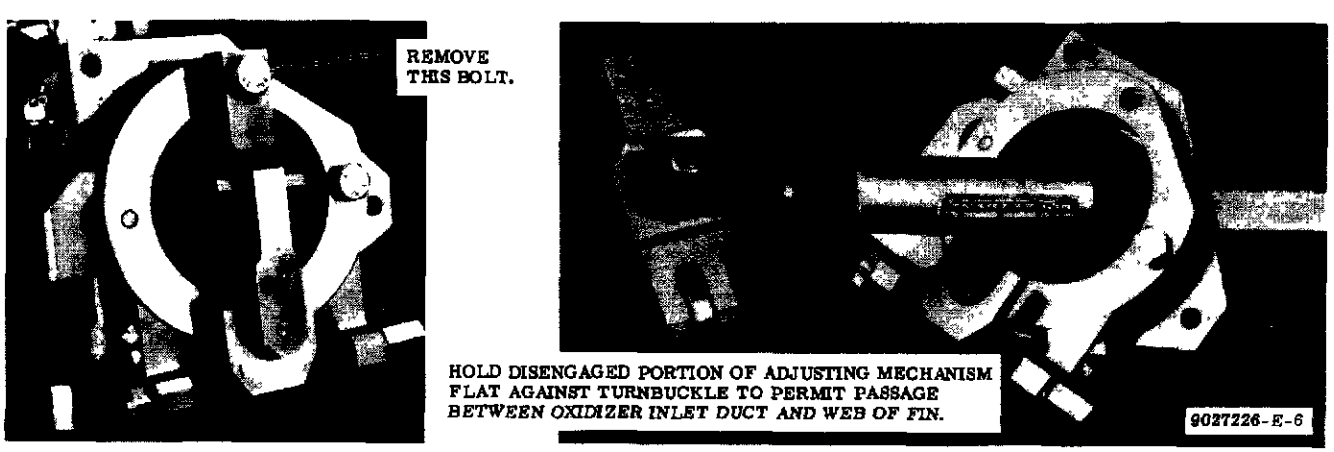

REMOVE THIS BOLT.
HOLD DISENGAGED PORTION OF ADJUSTING MECHANISM FLAT AGAINST TURNBUCKLE TO PERMIT PASSAGE BETWEEN OXIDIZER INLET DUCT AND WEB OF FIN.
9027226-E-6

Figure 2-53. Preparing Turnbuckle for Installation (Oxidizer Side)

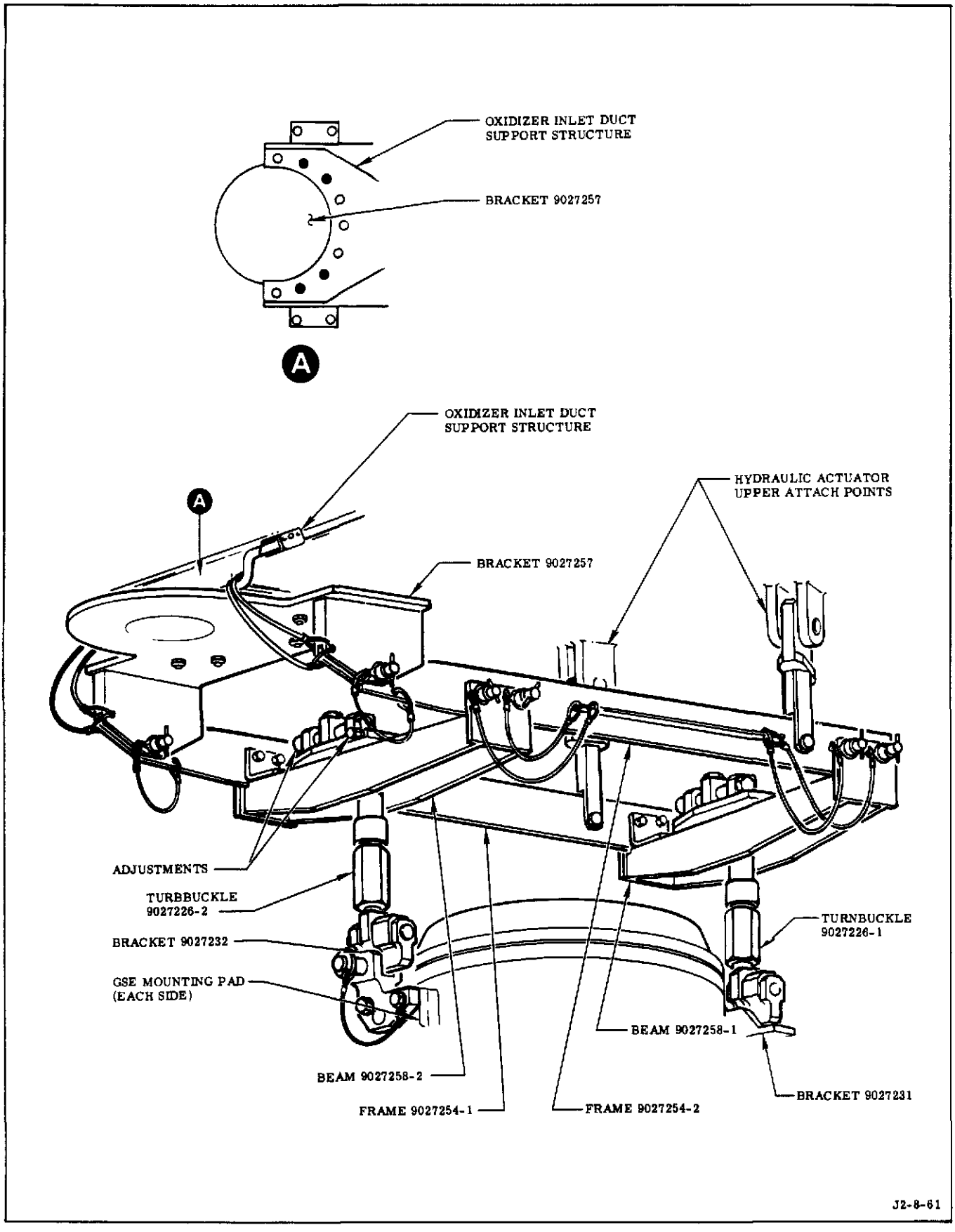


Figure 2-54. Lower System Installed (SIVB)

Nomenclature	Part Number	Number Required (one unless noted)	Shelf Number
Turnbuckle(a)	9027226-1		2
Bracket(a)	9027232		2
Turnbuckle(a)	9027226-2		2
Bracket(a)	9027231		2
Bolts(b)	9027227	4	2
Frame	9027254-1		2
Frame	9027254-2		2
Bracket	9027257		2
Beam	9027258-1		2
Beam	9027258-2		2

(a) Stored assembled
(b) Captive in bracket 9027231

Figure 2-55. G4072 Parts Required to Install Lowering System (SIVB)

b. Obtain torque wrenches with ranges of 120-155 inch-pounds, 330-430 inch-pounds, and 520-680 inch-pounds, 12 Fist Grip Clips G-429-1/4 (Crosby-Laughlin) or equivalent, and two 16-18 foot lengths of 1/4-inch cable. Cable must be 6x19 or 7x19 galvanized or stainless steel with a minimum breaking strength of 6,000 pounds.

c. Remove hydraulic actuators from engine in accordance with applicable stage procedures.

d. Remove oxidizer and fuel inlet ducts. (Refer to paragraphs 3-66 and 3-24.)

e. Attach bracket 9027232 to GSE mounting pad on oxidizer side of engine (figure 2-54). Torque bolts to 520-680 inch-pounds.

f. Attach bracket 9027231 to GSE mounting pad on fuel side of engine with 4 captive bolts. Torque bolts to 330-430 inch-pounds. (Refer to R-3825-3.)

g. Remove 4 bolts from oxidizer inlet support structure that match boltholes in bracket 9027257. (See figure 2-54.)

h. Install bracket 9027257. Torque bolts to 120-155 inch-pounds. Install bolts from top (stage) side, and shim bolts with washers, as necessary, to prevent bolt threads from bottoming while permitting bolt to protrude through bracket for full engagement with nut. Install nuts and torque to 120-155 inch-pounds.

i. Install frames 9027254-1 and 9027254-2 as shown in figure 2-54.

j. Shorten both turnbuckles to minimum length.

WARNING

Missing roll pins can allow the turnbuckle to be extended beyond safe limits, causing damage to equipment and injury to personnel.

k. Roll back rubber sleeve on each turnbuckle, and check that roll pins are installed. (See figure 2-43.) Turnbuckles must not be used without roll pins installed. Replace rubber sleeves over slots.

l. Adjust lower end of both turnbuckles to position shown in figure 2-44. This permits passage through limited access hole in beams.

m. Attach turnbuckle 9027226-2 to beam 9027258-2 by inserting lower end of turnbuckle through beam (figure 2-45) and engaging upper adjusting mechanism to studs in beam.

n. Install turnbuckle and beam to frame on oxidizer side of engine. Make sure that adjustments at top of turnbuckle are toward operator. (See figure 2-54.)

o. Make sure same number of threads (within one thread) show at each end of turnbuckle; adjust, if necessary.

p. Lengthen turnbuckle, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

q. Adjust lower end of turnbuckle to dimension shown in figure 3-26.

r. Shorten turnbuckle to take up slack.

s. Attach turnbuckle 9027226-1 to beam 9027258-1, and install turnbuckle and beam to frames in same manner as previous assembly, except install on fuel side of engine.

t. Make sure same number of threads (within one thread) show at each end of turnbuckle; adjust, if necessary.

u. Lengthen turnbuckle, maintaining same number of threads at each end, to aline attach points of turnbuckle and bracket on thrust chamber. Secure turnbuckle to bracket with captive ball-lock pin.

v. Adjust lower end of turnbuckle to dimension shown in figure 3-26.

w. Shorten turnbuckle to take up slack.

x. Inspect installation. All ball-lock pins must be fully engaged. Bolts that secure brackets to oxidizer inlet support structure and thrust chamber must be seated and torqued.

y. Install cables as shown in figure 2-47 (SIVB stage). Adjust effective length of cables so that total slack will permit required lowering of engine, plus a maximum of 2 inches. However, under no condition is total slack to exceed 7 inches.

2-28. PREPARING TURNBUCKLES FOR USE (SII STAGE). Turnbuckles 9027226-2 and 9027226-11 use common parts that may require exchanging before the required turnbuckle is usable. Exchanging these parts requires no special information or tools. See figure 2-56 for an illustration of parts to be exchanged and their attach points.

2-29. REMOVING ENGINE LOWERING SYSTEM. Remove engine lowering system in reverse order of installation. When reconnecting HYDROGEN TANK PRESSURIZATION hose, install seal, and cross-torque bolts to 30-40 inch-pounds.

WARNING

Exceeding 400 pounds per quadrant (bridge sections included), applying excessive lateral force to the heat shield, or bumping the heat shield support struts can result in damage to equipment and injury to personnel.

NOTE

Loads applied to the heat-shield protective pad bridge sections are to be considered as being applied to each adjacent quadrant, reducing the permissible load on these quadrants accordingly. Example: A 170-pound man standing on a bridge section and holding a 50-pound component, reduces the allowable weight on each of the adjacent quadrants by 220 pounds.

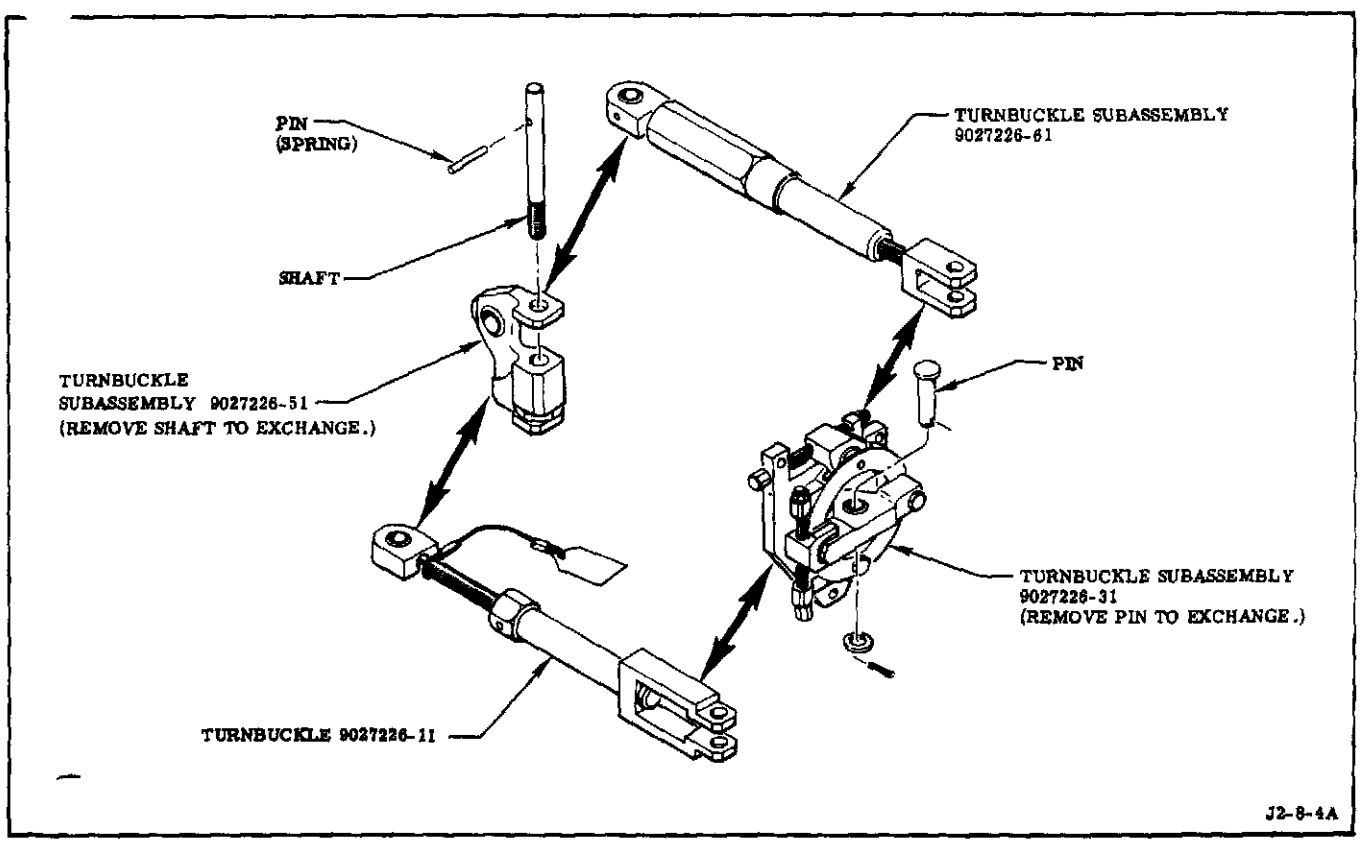


Figure 2-56. Preparing Turnbuckles for Use

2-30. INTERNAL ACCESS PLATFORM.

2-31. The internal access platform allows a technician to stand inside the thrust chamber for installation of the thrust chamber throat plug. When installed and unfolded, the platform provides a level surface for standing. The platform has a maximum working load of 250 pounds, sufficient for one man and the throat plug.

2-32. INSTALLING INTERNAL ACCESS PLATFORM. The internal access platform is required to remove or install the thrust chamber throat plug. Obtain internal access base 9027219 and internal access platform 9027211 from shelf 3 of stowage cart. (Refer to section I.) Also obtain a 0-250 inch-pound torque wrench.

WARNING

Helium may be trapped in the thrust chamber. An air supply or self-contained air-breathing apparatus must be used to prevent injury or death to personnel.

CAUTION

Since access to the thrust chamber interior over the stage bulkhead is limited, components and tools must be handled with extreme care to prevent damaging the components or bulkhead when installing the internal access platform.

a. Provide access through stage work deck, large enough to permit passage of internal access platform 9027211.

b. Remove closure from thrust chamber exit flange.

c. With 4 pads up, place internal access base on circumference of thrust chamber exit flange (any position) and aline boltholes. Install captive bolts. Torque bolts to 120-155 inch-pounds.

d. Install internal access platform in position shown in figure 2-57 as follows:

(1) Move internal access platform in a horizontal position below thrust chamber exit flange and to a vertical position within thrust chamber interior.

(2) Lift internal access platform and place protectors over adapters on internal access base; then carefully rest top of internal access platform against thrust chamber tubes.

(3) Remove ball-lock pins.

(4) Push step upward until ball-lock pin holes aline; then reinstall ball-lock pins.

2-33. REMOVING INTERNAL ACCESS PLATFORM. Remove internal access platform in reverse order of installation.

CAUTION

Handle components and tools with extreme care when removing internal access platform, since access to the thrust chamber interior over the stage bulkhead is limited, and damage to components or bulkhead can result.

2-34. ACCESS WORK PLATFORM.

2-35. The access platform enables access to engine components below the stage work deck by providing a work surface approximately 5 feet below the stage work deck. The access platform accommodates one man and installs through the opening provided when two adjacent pie-shaped sections of the work deck are removed. On 500-series stages where removal of the two pie-shaped sections leaves a larger-than-required opening, a cover is provided to safely cover the excess.

2-36. INSTALLING ACCESS WORK PLATFORM.

a. Obtain frames 9024598-1 and 9024598-2 from shelf 5 and platform 9025848 from shelf 4 of Engine Components Installer G4072 stowage cart. If access work platform is to be installed in a 500-series stage, obtain cover 9027216 from shelf 5.

b. Insert frames into sockets in platform and secure frames with attached ball-lock pins. Frames are to be installed with the padded flanges outboard and the struts (braces) at the wide end of the platform.

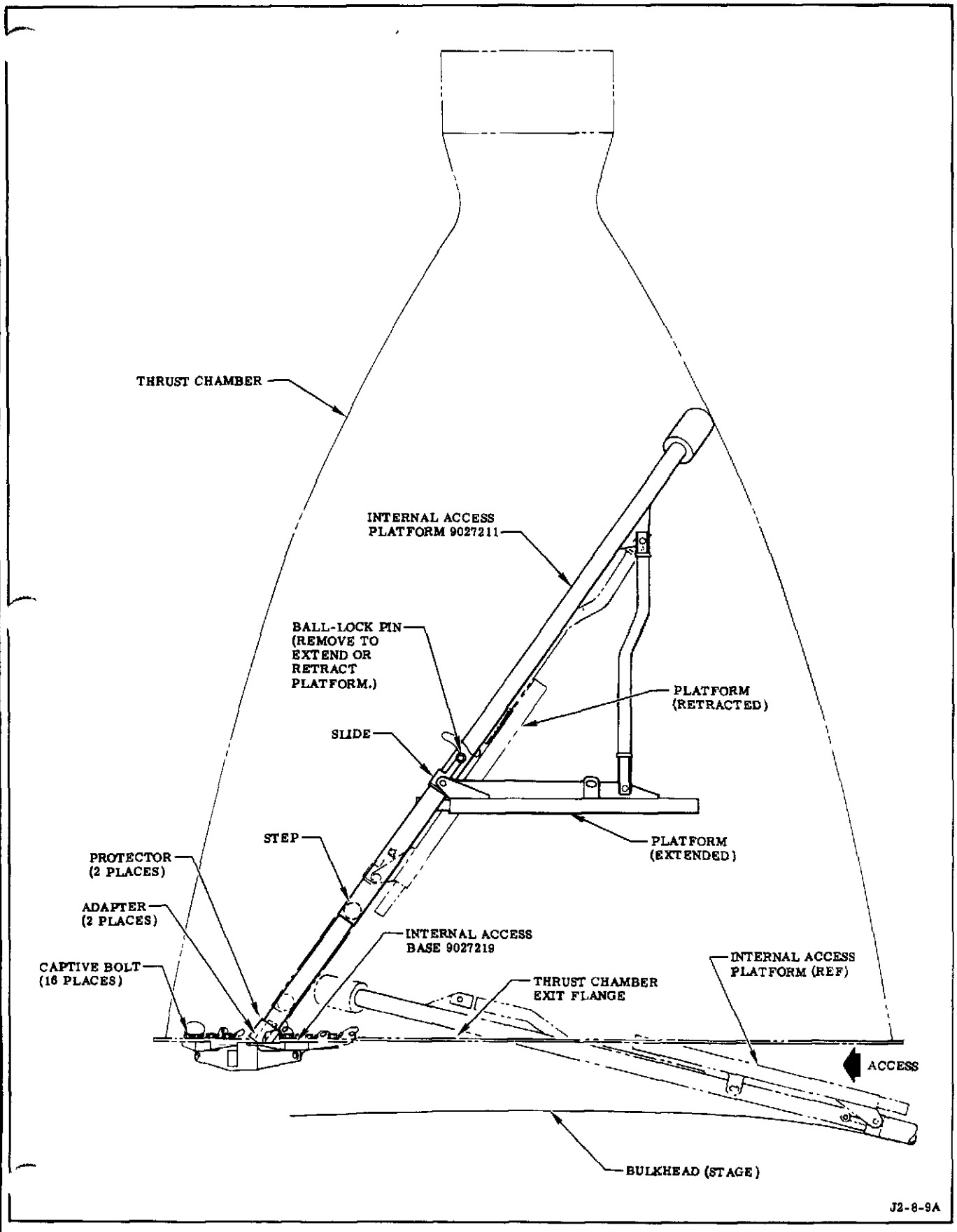


Figure 2-57. Installing Internal Access Platform

c. Attach the two struts (braces) to their respective attach points on the opposite frame.

d. Remove the two required adjacent pie-shaped sections of the work deck in accordance with stage procedures.

e. If access work platform is being installed in a 200-series stage, place cover over widest (outboard) end of opening. Place cover into opening with the side containing 3 square tube pieces down. Slide cover inboard as far as it will go.

f. Make sure small hinged extension of platform is folded back onto main portion of platform.

g. Hold short spring-loaded arms at top of access work platform fully inboard and carefully lower platform into opening provided by removal of pie sections until padded sections rest on stage work deck. Make sure platform does not contact engine.

WARNING

If spring loaded arms are not fully outboard or securely against lower surface of work deck, an unstable condition will exist that can result in injury to personnel or damage to equipment.

h. Release spring-loaded arms and force arms outboard until they stop or are securely against lower surface of work deck.

i. Rotate small hinged section of platform to provide additional work surface.

2-37. REMOVING ACCESS WORK PLATFORM. Remove access work platform in reverse order of installation (paragraph 2-36). Make sure small hinged extension of platform is folded back onto main portion of platform before removing access work platform.

2-38. ELEVATED TRACK (SIVB STAGE).

2-39. The elevated track in conjunction with the hoist provides the capability of lifting or lowering engine components to transfer the component from or to the stage.

2-40. INSTALLING ELEVATED TRACK (200 SERIES).

a. Obtain a carpenter level and the following parts from Engine Components Installer Set 9026252:

(1) Base 9026990 (two required)

(2) Extension 9026991

(3) Extension 9026991-11

(4) Support pin 9027161

(5) Stop 9027156

b. Obtain one extension 9027196 from shelf 1 of Engine Components Installer G4072.

c. Move hoist to a position on track where none of hoist's weight will be applied to track section 9027162 (nearest stage access door). Apply hoist brake.

d. Remove stop and track section 9027162 (nearest stage access door). Retain track section, extensions, track pins, support pins, one base 9027171, and one base 9027164 for use in assembling elevated track. Retain remainder of parts for reuse when lower track is reassembled.

e. Remove hoist from lower track and hand-carry hoist outside of stage.

f. Assemble and position elevated track as shown in figure 2-58 except do not install stop at outboard end of track. Observe the following:

(1) Secure extensions 9027196 to track or stops with support pins. Tighten pin sufficiently to seat heads.

(2) Secure track sections to stop with track pins. Make sure pins do not protrude beyond side of stops.

(3) Level (use carpenter level) track by adjusting height of extensions 9027196. If extension adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp). To compensate for deflection of stage work deck, it may be necessary to pin extension 9026991-11 to base 9026990 using lower hole of each pair of holes.

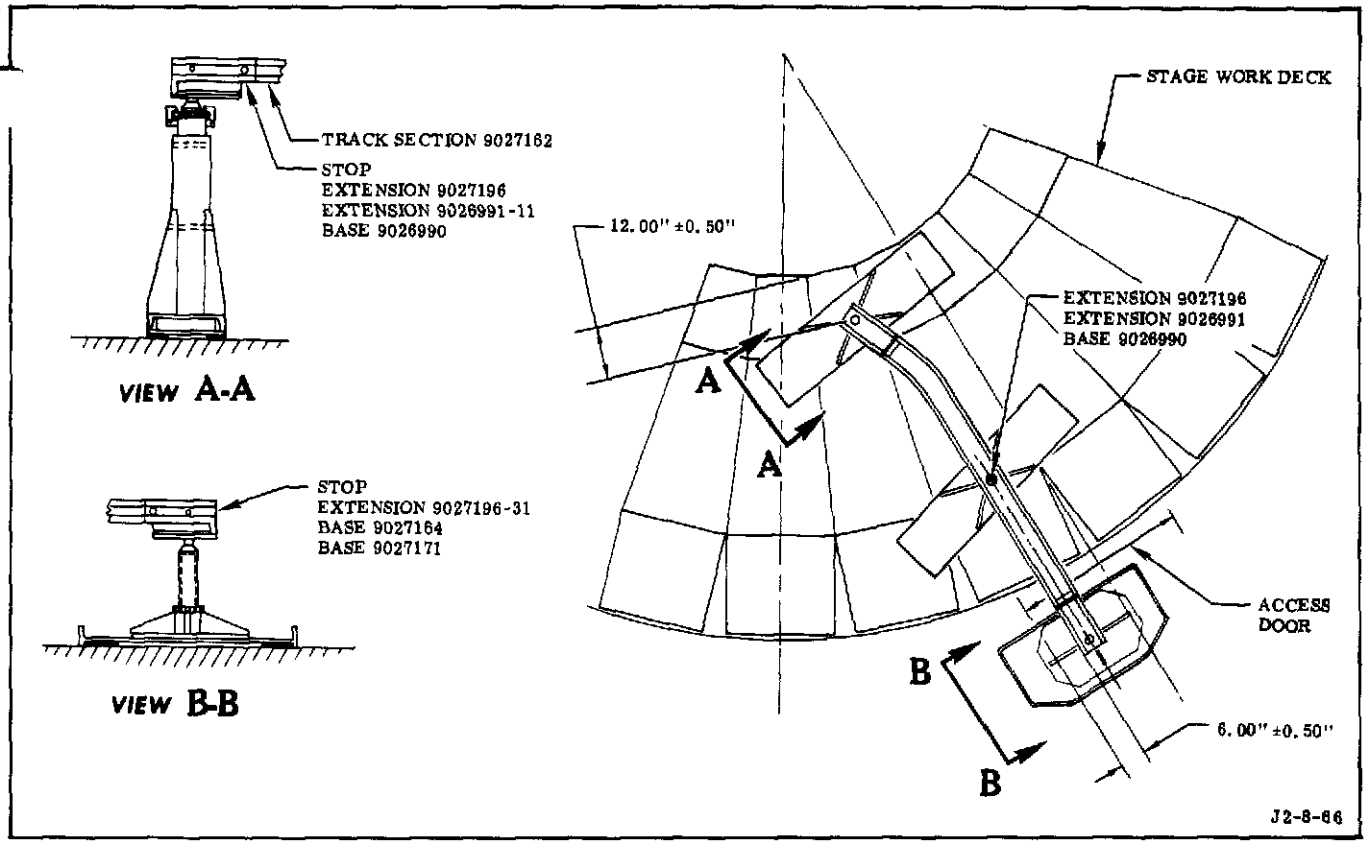


Figure 2-58. Location of Track Components for Elevated Track (200-Series Stage)

(4) Lock extensions 9026991 and 9026991-11 to extensions 9027196 by securing locks into spanner wrench holes of adjustment nuts.

g. Install turntable onto track with controls leading. Position hoist at or beyond first track support before allowing full weight of hoist to be applied to track. Apply hoist brake.

h. Install remaining stop, bases, and extension. (See figure 2-58.) Adjust extension as required to maintain track level. If extension adjustment nut is difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

2-41. INSTALLING ELEVATED TRACK (500 SERIES).

a. Obtain a carpenter level and the following parts from Engine Components Installer Set 9026252:

(1) Base 9026990 (two required)

(2) Extension 9026991

(3) Extension 9026991-11

(4) Support pin 9027161

(5) Stop 9027156

(6) Support 9026993

b. Obtain one extension 9027196 from shelf 1 of Engine Components Installer G4072.

c. Move hoist to a position on the track where none of the hoist's weight will be applied to track section 9027162 (nearest stage access door). Apply hoist brake.

d. Remove stop and track section 9027162 (nearest stage access door). Retain track section, extensions, track pins, support pins, one base 9027171, and one base 9027164 for use in assembling elevated track. Retain remainder of parts for reuse when lower track is reassembled.

e. Remove hoist from lower track and hand-carry hoist outside of stage.

f. Assemble and position elevated track as shown in figure 2-59. Observe the following:

(1) Start track assembly with support and stop at outboard end of illustration (figure 2-59).

(2) Secure extensions 9027196 to track or stops with support pins. Tighten pin sufficiently to seat heads.

(3) Secure track sections to stop with track pins. Make sure pins do not protrude beyond side of stops.

(4) Level (use carpenter level) track by adjusting height of extensions 9027196. If extension adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp). To compensate for deflection of stage work deck, it may be necessary to pin extension 9026991-11 to base 9026990 using the lower hole of each pair of holes.

(5) Lock extensions 9026991 and 9026991-11 to extensions 9027196 by securing locks into spanner wrench holes of adjustment nuts.

g. Remove support and stop at outboard end of track.

h. Install turntable onto track with controls leading. Position hoist at or beyond first track support before allowing full weight of hoist to be applied to track. Apply hoist brake.

i. Replace support and stop on outboard end of track.

2-42. REMOVING ELEVATED TRACK AND REASSEMBLING LOWER TRACK.

a. Position hoist near inboard end of track and apply hoist's brake.

b. Remove stop and support (500 series), or stop, extension, and bases (200 series) from outboard end of track.

c. Remove hoist from track, and temporarily store hoist outside of stage. While removing hoist, do not allow hoist's weight to be applied to unsupported end of track section.

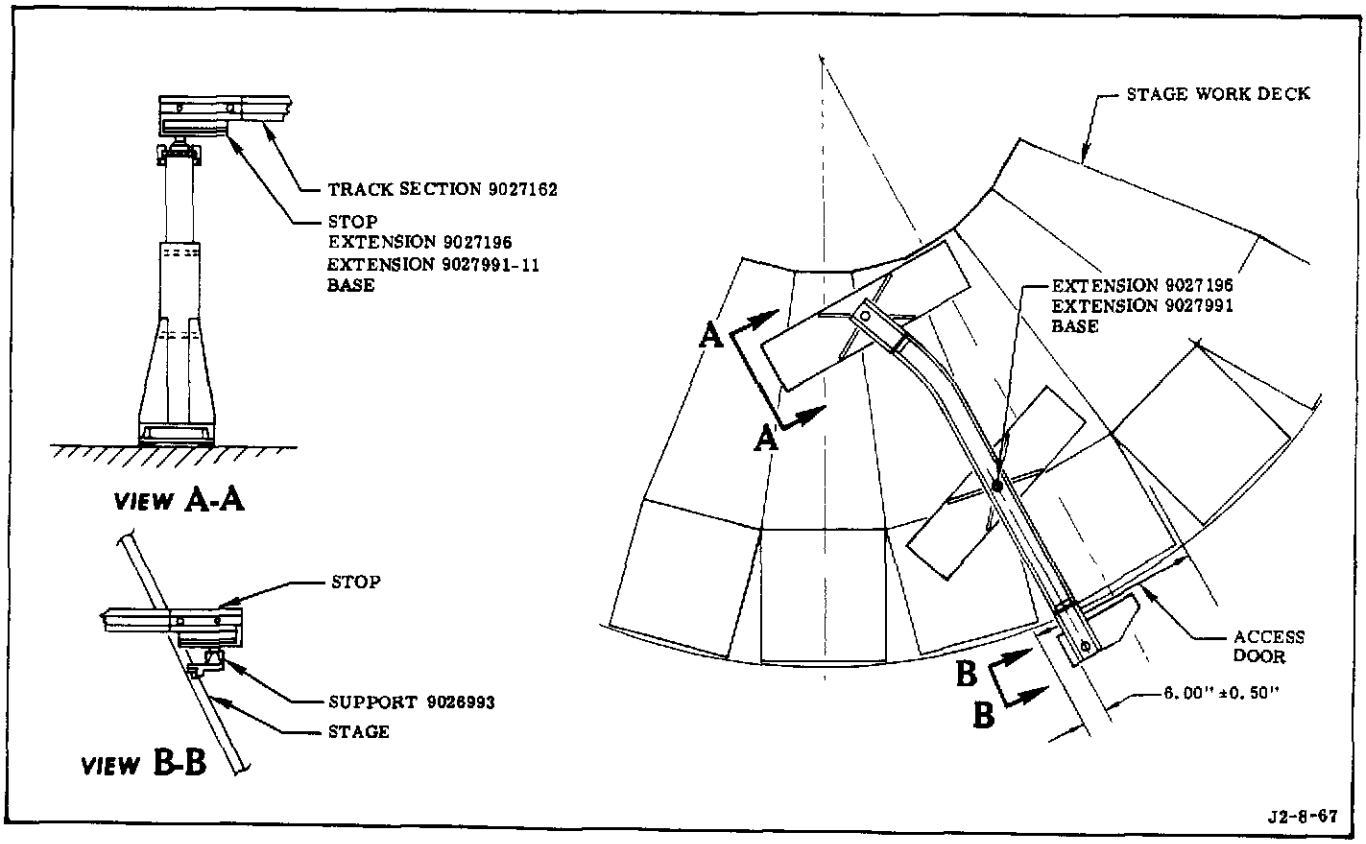


Figure 2-59. Location of Track Components for Elevated Track (500-Series Stage)

d. Disassemble remainder of track.

e. Reinstall track section 9027162 with necessary bases and extensions to original lower configuration. Refer to figure 2-49 (SIVB, 200 series) or figure 2-50 (SIVB, 500 series) for illustration of original track configuration. Do not install stop at this time.

f. Hand-carry hoist into stage, and install hoist on track. Install hoist with controls positioned, as required, in removal procedures of component being installed. Position hoist at or beyond first track support before allowing hoist's weight to be applied to track.

g. Install stop, extension, and bases on end of track.

h. Make sure support pins are tightened sufficiently to seat heads of pin and track pins do not protrude beyond outside surfaces of track.

i. Level reinstalled track section to match existing track by adjusting extensions. If extension adjustment nuts are difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

j. Return surplus parts from elevated track to their respective installer or installer set. (Refer to section I.)

SECTION III

ROCKET ENGINE COMPONENT REMOVAL AND INSTALLATION

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3-1. SCOPE. This section contains procedures for removing and installing fourteen rocket engine components from engines installed in the SII and SIVB stages of Saturn vehicles. The procedures are based on using Engine Components Installers G4071 and G4072 and engine components installer sets 9026251 and 9026252. The procedures are limited to components which, due to their bulk and/or weight, require the use of the track and hoist. Lighter weight components are handled manually, using slings and straps provided in the installer and installer sets.

3-2. GENERAL INFORMATION.

3-3. Procedures contained in this section are based on the assumption that stage work decks, heat shields, and heat shield protective pads are installed, where applicable; capability for transporting parts of the installers and installer sets into the stage is provided; and adequate lighting for component removal and installation is provided. The first steps in each removal procedure, except one (fuel turbine exhaust , SIVB) is assembly of the track, turntable, and boom. Performance of this task at this time is not mandatory, but may, at the discretion of the using personnel, be performed at any point prior to the procedural requirement to attach the boom to the component. Similarly, installation procedures contain a step to disassemble and remove the installer when no longer required. Performance of this step in sequence is optional and may be delayed, if desired, until the component installation is complete and the component tested. No requirement to assemble the installer is made in the installation procedures, since it is assumed that equipment required to remove the component will remain assembled for component reinstallation. Removal and installation of components from a J-2 rocket engine involves tasks which require specialized knowledge and techniques for their successful completion. Specialized requirements of these tasks (tube cutting, torquing, connecting and disconnecting electrical connectors, and protecting against contamination) is found in R-3825-3. Personnel performing the component removal and installation tasks contained in this section must be knowledgeable of these requirements.

3-4. SAFETY PRECAUTIONS. Warning and cautions are used throughout the text to indicate potentially dangerous conditions. These warnings and cautions must be strictly observed by personnel performing the procedures. Specific precautions to follow are given when a task involves working with potentially dangerous materials or hazardous conditions. The following examples explain warnings and cautions:

WARNING

A warning indicates a procedure or practice which, if not followed correctly, can result in personal injury or death.

CAUTION

A caution indicates a procedure or practice which, if not followed correctly, can result in damage to equipment.

3-5. AUXILIARY FLIGHT INSTRUMENTATION PACKAGE.

3-6. The auxiliary flight instrumentation package (figure 3-1) may be replaced without affecting engine calibration.

3-7. REMOVING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (SII STAGE). The weight of the auxiliary flight instrumentation package (approximately 30 pounds) does not require use of Engine Components Installer G4071. The following procedure, using the engine components installer, is presented in the event a heavier component, requiring the use of the installer, is to be removed concurrently with the auxiliary flight instrumentation package.

a. Obtain the following equipment and materials:

(1) Auxiliary flight instrumentation package handler 9027225, from Engine Components Installer G4071, shelf 3

(2) Single Head Special Tool Kit G3127

b. Obtain closures, or suitable equivalents, for electrical connectors and tube ends. Closures must be certified clean for use in a propellant system.

c. Whenever accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Cutting tubes

(2) Disconnecting electrical connectors

(3) Installing closures

d. Disconnect connectors P150, P151, and P152. (See figure 3-1.)

e. Using appropriate tube cutter, from Single Head Special Tool Kit G3127, cut instrumentation tubes.

f. Attach handler to auxiliary flight instrumentation package. (See figure 3-1.) Wrap handler strap around package and secure with ball-lock pin.

g. Support auxiliary flight instrumentation package by connecting boom to handler and secure with ball-lock pin.

h. Disconnect ground cable, and remove hardware attaching package to strut and clevises.

i. Install protective closures on all open ports.

j. Using hoist, transfer auxiliary flight instrumentation package to stage access door. Remove package from handler, and manually remove package from vehicle.

3-8. INSTALLING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (SII STAGE).

a. Obtain the following equipment and materials:

(1) Auxiliary flight instrumentation package handler 9027225, from Engine Components Installer G4071, shelf 3

(2) Torque wrench, capable of torquing to 27-70 inch-pounds

(3) Silicon-carbide abrasive cloth or paper, 320-grit or finer

(4) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

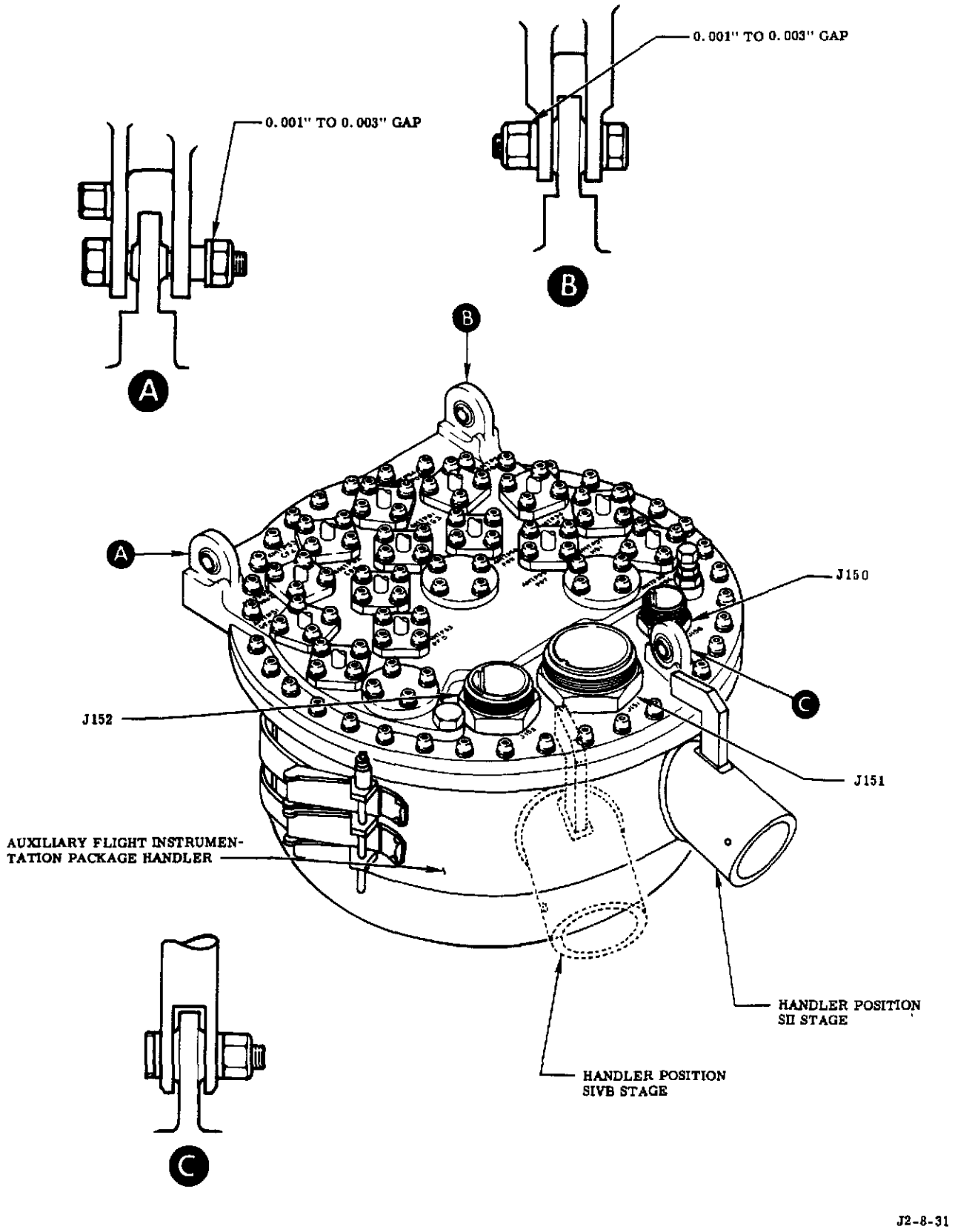


Figure 3-1. Auxiliary Flight Instrumentation Package

(5) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(6) Single Head Special Tool Kit G3127

(7) Automatic Inert Gas Arc Welding Set G3128

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Performing in-place tube welds

(2) Connecting electrical connectors

(3) Removing closures

(4) Torquing

(5) Safetywiring

c. Install handler on auxiliary flight instrumentation package. (See figure 3-1.) The engaging lug FLANGE SIDE must be located adjacent to receptacle J151.

d. Connect handler to boom and secure with ball-lock pin; then position hoist at track station 24 for engine positions 1 through 4, and track station 9 for engine position 5.

e. Remove closures, as required during installation, to initiate connections.

f. Using hoist, move auxiliary flight instrumentation package into position on engine.

g. Aline package with clevises and strut. Attach package to clevises with bolts, washers, spacers, and nuts. (See figure 3-1.) Do not torque bolts at this time.

h. Attach package to strut with pin, washers, and nut. Torque nut to 50-70 inch-pounds.

i. Tighten fasteners attaching package to clevises until 0.001- to 0.003-inch gap exists between nut and washer.

j. Remove handler from auxiliary flight instrumentation package.

k. Disassemble track. (Refer to section II.)

NOTE

To prevent corrosion, steps 1 through o must be completed within 24 hours.

l. Using abrasive cloth, clean contact surfaces of ground cable terminal and its mating part of all protective finishes and foreign material.

m. Connect ground cable to clevis with bolt and washer. Torque bolt to 27-33 inch-pounds and safetywire.

n. Check resistance between auxiliary flight instrumentation package and thrust chamber. Resistance must not exceed 100 milliohms.

o. Apply a coating of lacquer premixed with blue dye on bonding area.

p. Weld instrumentation tubes.

q. Install electrical connectors P150, P151, and P152.

r. Refer to R-3825-3 for post-maintenance test .

3-9. REMOVING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (SIVB STAGE). The weight of the auxiliary flight instrumentation package (approximately 30 pounds) does not require use of Engine Components Installer G4072. The following procedure, using the engine components installer, is presented in the event the integral hydrogen-helium start tank, which requires the use of the installer, is to be removed concurrently with the auxiliary flight instrumentation package.

a. Obtain the following special tools:

(1) Auxiliary flight instrumentation package handler 9027225 from Engine Components Installer G4072, shelf 3

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(4) Single Head Special Tool Kit G3127

(5) Component handler universal lifting sling 9016779

(6) Component handling cart 9026253 from engine components installer set 9026252

(7) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

b. Obtain closures, or suitable equivalent, for electrical connectors and tube ends. Closures must be certified clean for use in a propellant system.

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

d. Disconnect connectors P150, P151, and P152. (See figure 3-1.)

e. Using appropriate tube cutter, from Single Head Special Tool Kit G3127, cut instrumentation tubes.

f. Install sleeve, extension, and handler on hoist. (See figure 3-2, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

g. Manipulate hoist to lower handler through opening in which lower work platform is installed and orient handler with package.

h. Attach handler to auxiliary flight instrumentation package. (See figure 3-1.) Wrap handler strap around package and secure with ball-lock pin.

CAUTION

A minimum of one thread must be evident in turnbuckle adjusting barrel to make sure turnbuckle operates safely.

i. Support auxiliary flight instrumentation package by manipulation of hoist and turnbuckle on extension. If turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel. Make sure side load does not exist on auxiliary flight instrumentation package.

j. Disconnect ground cable, and remove hardware attaching package to strut and clevises.

k. Install closures on all open ports.

CAUTION

A minimum of one thread must be evident in turnbuckle adjusting barrel to make sure turnbuckle operates safely.

l. Make sure auxiliary flight instrumentation package is free of engine; then, with hoist and extension turnbuckle, move auxiliary flight instrumentation package clear of engine and through opening in which lower work platform is installed. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in raising component through stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the auxiliary flight instrumentation package to the stage work platform; therefore, it may be necessary for a technician to guide the package and to assist the hoist operator.

m. Using hoist, move auxiliary flight instrumentation package to an accessible area near stage access door.

n. Remove handler (with auxiliary flight instrumentation package attached) from hoist and temporarily place on protective pad. Install component handler universal lifting sling on handler and secure with ball-lock pin.

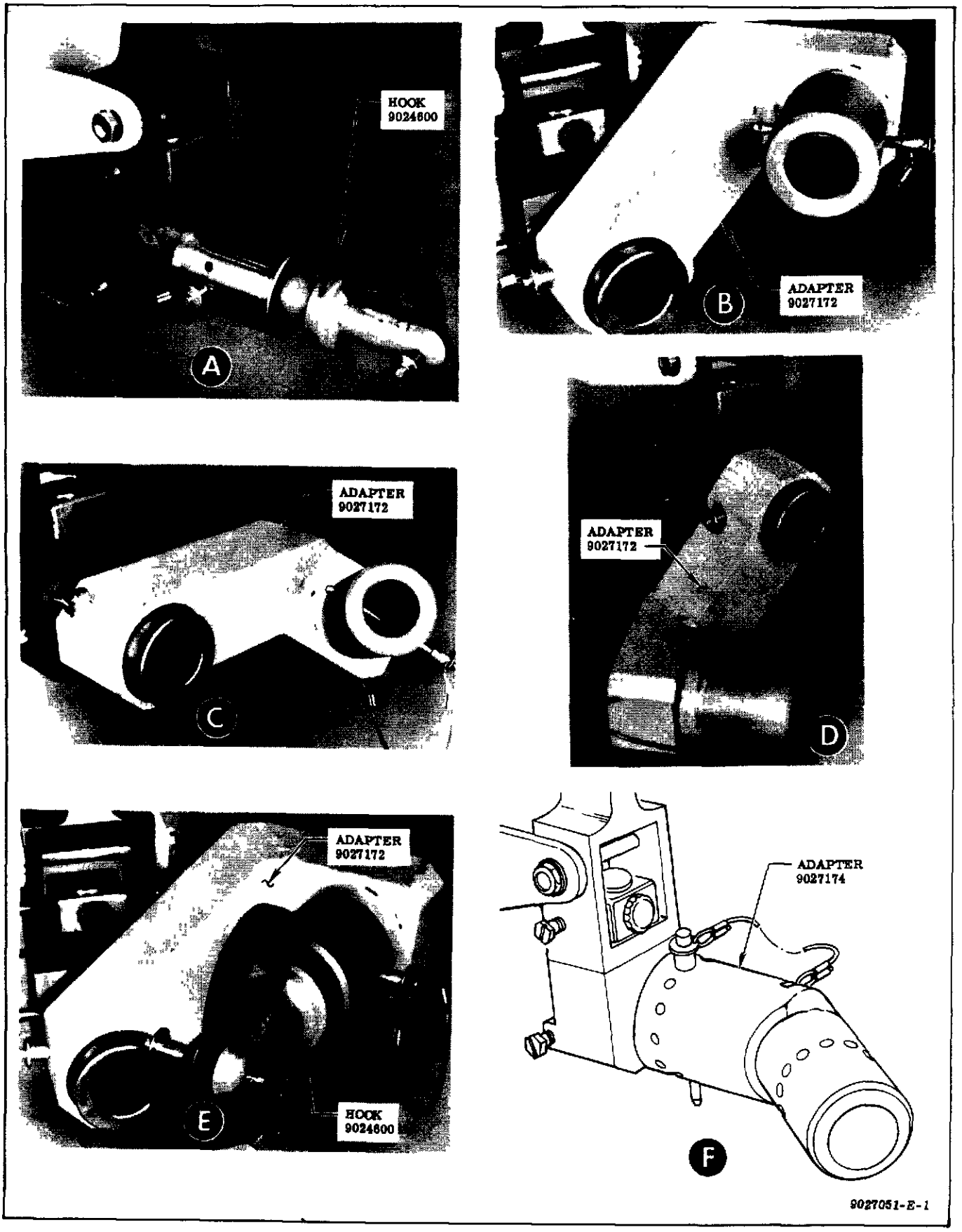


Figure 3-2. Hoist Adapter and Extension Arrangements (Sheet 1 of 2)

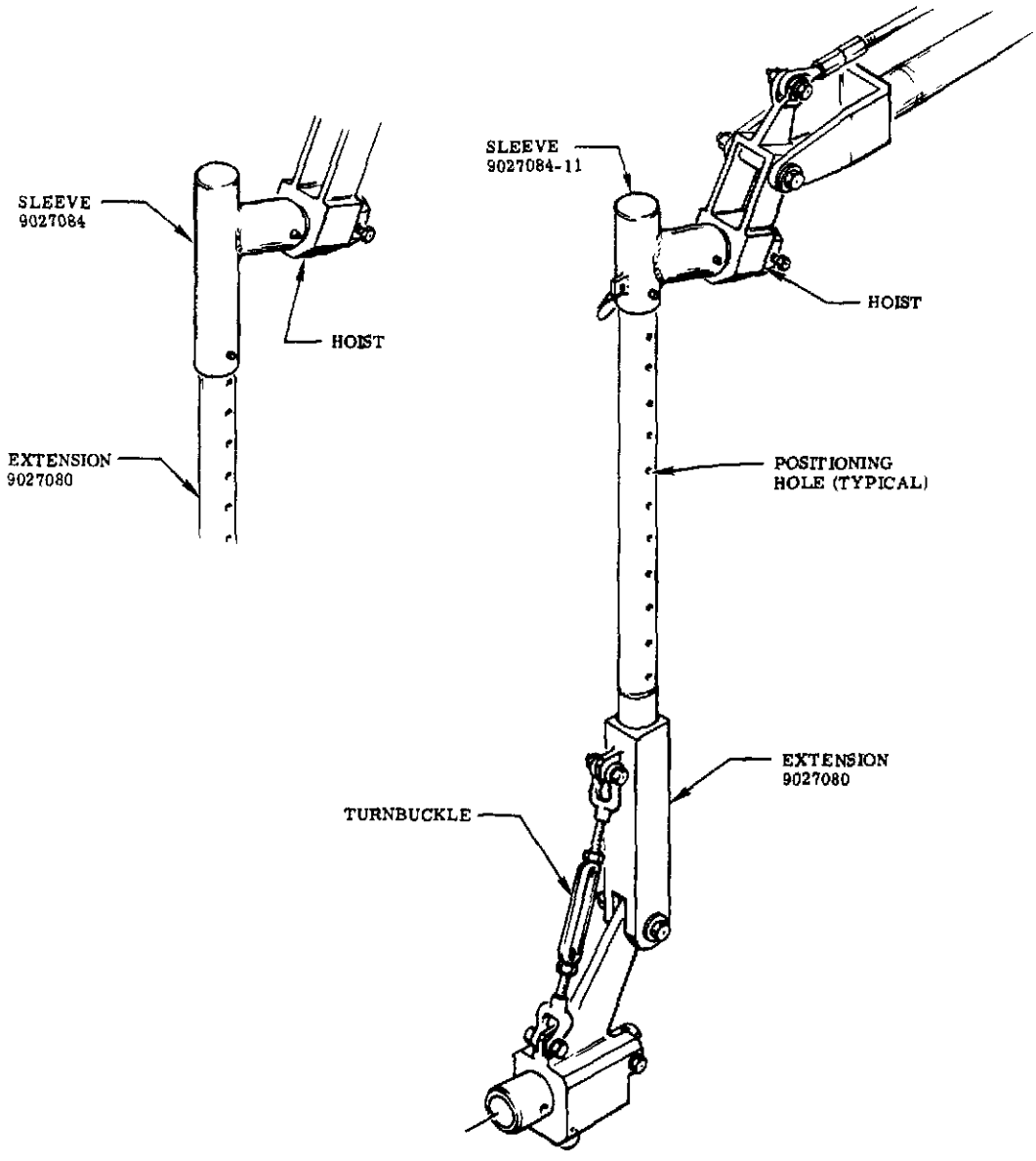


Figure 3-2. Hoist Adapter and Extension Arrangements (Sheet 2 of 2)

NOTE

The combined weight of auxiliary flight instrumentation package, sling, and handler is approximately 37 pounds.

o. Using lifting eye on sling, manually ınsport auxiliary flight instrumentation package through stage access door and place package in component handling cart.

3-10. INSTALLING AUXILIARY FLIGHT INSTRUMENTATION PACKAGE (SIVB STAGE).

a. Obtain the following special tools and materials:

(1) Auxiliary flight instrumentation package handler 9027225 from Engine Components Installer G4072, shelf 3

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(4) Component handler universal lifting sling 9016779

(5) Torque wrench capable of torquing to 27-70 inch-pounds

(6) Silicon-carbide abrasive cloth or paper, 320-grit or finer

(7) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

(8) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(9) Single Head Special Tool Kit G3127

(10) Automatic Inert Gas Arc Welding Set G3128

(11) Component handling cart 9026253 from engine components installer set 9026252

(12) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

c. Using cart, transport auxiliary flight instrumentation package to stage. Transfer package into stage and place on protective pad. A suggested method of handling the auxiliary flight instrumentation package is as follows:

(1) Install handler on auxiliary flight instrumentation package. (See figure 3-1.) The engaging lug FLANGE SIDE must be located adjacent to receptacle J151.

(2) Wrap handler straps around package and secure with ball-lock pin.

(3) Attach component handler universal lifting sling on handler and secure with ball-lock pin.

NOTE

The combined weight of auxiliary flight instrumentation package, sling, and handler is approximately 37 pounds.

d. Install sleeve and extension on hoist. (See figure 3-2, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hold (200-series stage) from turnbuckle. Secure with ball-lock pin.

e. Install handler on hoist extension. If handler is installed on auxiliary flight instrumentation package (step c), remove sling. If handler is not installed, install handler as outlined in step c, except do not install sling.

CAUTION

A minimum of one thread must be evident in turnbuckle adjusting barrel to make sure turnbuckle operates safely.

f. Using hoist, lower auxiliary flight instrumentation package through opening in which lower access platform is installed, and position on engine. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in lowering component through stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the auxiliary flight instrumentation package to the engine; therefore, it may be necessary for a technician to guide and to assist the hoist operator.

g. Remove closures, as required during installation, to initiate connections.

h. Aline package with clevises and strut. Attach package to clevises with bolts, washers, spacers, and nuts. (See figure 3-1.) Do not torque bolts at this time.

i. Attach package to strut with pin, washers, nut. Torque nut to 50-70 inch-pounds.

j. Tighten fasteners attaching package to clevises until 0.001- to 0.003-inch gap exists between nut and washer. (See figure 3-1.)

k. Remove handler from auxiliary flight instrumentation package.

l. Remove handler, extension, and sleeve from hoist. Disassemble track. (Refer to section II.)

NOTE

To prevent corrosion, steps m through p must be completed within 24 hours.

m. Using abrasive cloth, clean contact surfaces of ground cable terminal and its mating part of all protective finishes and foreign material.

n. Connect ground cable to clevis with bolt and washer. Torque bolt to 27-33 inch-pounds and safetywire.

Check resistance between auxiliary flight instrumentation package and thrust chamber. Resistance must not exceed 100 milliohms.

p. Apply a coating of lacquer premixed with blue dye on bonding area.

q. Weld instrumentation tubes.

r. Install electrical connectors P150, P151, and P152.

s. Refer to R-3825-3 for post-maintenance test.

3-11. ELECTRICAL CONTROL ASSEMBLY.

3-12. The electrical control assembly may be replaced without affecting engine calibration.

3-13. REMOVING ELECTRICAL CONTROL ASSEMBLY (SII STAGE).

a. Assemble track (refer to section II) around engine from which electrical control assembly is to be removed. Install turntable with controls leading, and position hoist at track station 7.5 for engine positions 1 through 4, and track station 25 for engine position 5.

b. Obtain the following equipment and materials: (Items 2 through 5 are not required if launch tower umbilical arm is to be used for transporting component from stage.)

(1) Sequence controller handler 9016789

(2) Component handler universal lifting sling 9016779

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Component handling cart 9026253 from engine components installer set 9026251

(7) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(8) Corrosion-preventive compound (MIL-C-11796, Class 3)

c. Obtain closures, or suitable equivalent, for electrical connectors. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Disconnecting electrical connectors

(2) Installing closures

e. Measure pressure in igniter cables as outlined in R-3825-1B; then depressurize igniter cable by backing off pressurizing valve locknut (see figure 3-3) 1-3 turns and depressing valve core.

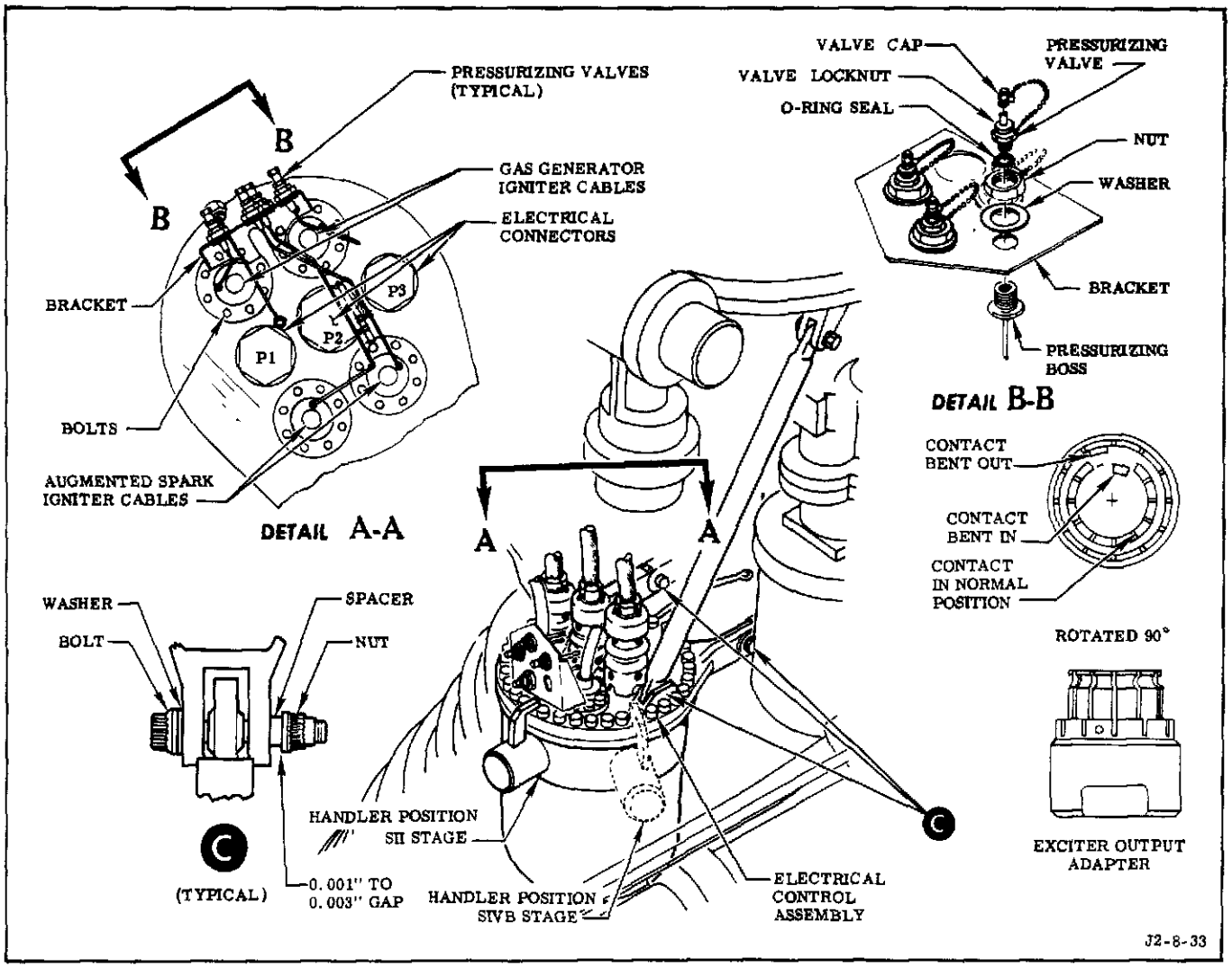


Figure 3-3. Electrical Control Assembly

WARNING

Applying electrical power to the engine when connecting or disconnecting electrical connectors and/or igniter cables or when igniter cables are disconnected can cause electrical arcing resulting in injury to personnel and damage to equipment.

f. Make sure all electrical power to engine is turned off.

g. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses and install closures on all open ports.

CAUTION

Care must be taken throughout the following procedures not to bend the igniter cable pressurizing tubes since damage can result.

h. Remove bolts that secure pressurizing valve mounting bracket to bell housing of gas generator igniter cables and remove bracket.

i. Remove remaining bolts that attach gas generator igniter cables to electrical control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on the cable bell housing can damage the igniter cable and electrical control assembly.

j. Remove gas generator igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step k immediately.

k. Install support ST3950166RKL001 and closures on igniter NA5-27448 as follows: (Install closures only on all other igniter cables and exciters.)

(1) Inspect interior of bell housing, to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbored holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

l. Install closures on igniter cables 651389 and 651390 and on exciters.

m. Temporarily secure cables to engine.

n. Disconnect electrical connectors P1, P2, and P3.

o. Remove nuts, washers, and screws from augmented spark igniter cable pressurizing tube support clamps.

p. Remove bolts that secure augmented spark igniter cables to control assembly.

CAUTION

Tipping or side motion of igniter cable bell housing before cable plug is clear of exciter output adapter can break or distort adapter fingers.

- Pulling on igniter cable or prying on cable bell housing can damage igniter cable and electrical control assembly.

q. Remove augmented spark igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step r immediately.

r. Install support ST3950166RKL001 and closure on igniter cable NA5-27448 as follows: (Install closures only on all other igniter cables and on exciters.)

(1) Inspect interior of bell housing, to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbored holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

s. Temporarily secure cables to engine.

t. Disconnect ground cable from bracket on thrust chamber.

u. Attach handler on electrical control assembly. (See figure 3-3.) Wrap handler strap around package and secure with ball-lock pin. On engines incorporating MD224 or 249 change, take care not to damage insulation on electrical control assembly.

v. Support electrical control assembly by connecting boom to handler and secure with ball-lock pin. Remove nuts, spacers, washers, and bolts that secure electrical control assembly to thrust chamber and rod. Make sure side load does not exist on electrical control assembly.

w. Make sure electrical control assembly is free of engine; then move electrical control assembly clear of engine.

x. If reinstallation will not be completed within 24 hours, coat all bonding surfaces with corrosion-preventive compound.

NOTE

If the launch tower umbilical arm is to be used for transporting component from stage, omit steps z through ad; otherwise, omit step y.

y. Using hoist, transfer electrical control assembly through stage access door and lower into component handler cart.

z. Using hoist, transfer electrical control assembly from engine and place on protective pad.

aa. Attach component handler universal lifting sling to handler on electrical control assembly.

ab. Install chain-hoist on hoist.

ac. Connect chain-hoist hook to component handler universal lifting sling.

ad. Raise electrical control assembly with chain-hoist, transport control assembly through stage access door, and lower control assembly into component handling cart.

3-14. INSTALLING ELECTRICAL CONTROL ASSEMBLY (SII STAGE).

a. Obtain the following equipment and materials: (Items 11 through 14 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Sequence controller handler 9016789

(2) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

(3) Torque wrench, capable of torquing to 15-42 inch-pounds

(4) Torque wrench, capable of torquing to 100-200 inch-pounds

(5) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(6) Sealing compound RB0140-005 (Rocketdyne)

(7) Abrasive cloth, 320-grit or finer

(8) FS1281 grease (Dow Corning Corp)

(9) Component handling cart 9026253 from engine components installer set 9026252

(10) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

(11) Component handler universal lifting sling 9016779

(12) Chain-hoist 9027095 from engine components installer set 9026251

(13) Universal joint S8 from engine components installer set 9026251

(14) Extension bar SX-24 from engine components installer set 9026251

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Torquing

(3) Safetywiring

WARNING

Applying electrical power to the engine when connecting or disconnecting electrical connectors and/or igniter cables or when igniter cables are disconnected can cause electrical arcing, resulting in injury to personnel and damage to equipment.

c. Make sure all electrical power to engine is turned off.

d. Before installing electrical control assembly, visually inspect threads in parent metal and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

e. Before installing electrical control assembly, inspect each exciter output adapter for bent or broken contacts as follows: (See figure 3-3.)

(1) Contacts bent less than 0.070 inch from normal position are acceptable; do not attempt to straighten.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than 2 broken contacts (any position) are acceptable.

(4) If any one adapter has more than 2 broken contacts, replace electrical control assembly.

NOTE

If the launch tower umbilical arm is to be used for transporting the component to the stage, omit steps g through l; otherwise omit step f.

f. Using cart, transport electrical control assembly to stage. Transfer control assembly into stage and place on protective pad. A suggested method of handling electrical control assembly is as follows:

(1) Install handler on electrical control assembly. (See figure 3-3.) The engaging lug FLANGE SIDE must be located between gas generator igniter cable receptacle G3 and electrical control assembly support bracket.

(2) Wrap handler straps around electrical control assembly and secure with ball-lock pin. On engines incorporating MD224 or MD249 change, take care not to damage electrical control assembly insulation.

(3) Attach component handler universal lifting sling on handler and secure with ball-lock pin.

g. Using cart, transport electrical control assembly to stage.

h. Install handler and sling on electrical control assembly. (Refer to step e.)

. Install chain-hoist on hoist.

j. Connect chain-hoist hook to sling.

k. Raise electrical control assembly with chain-hoist and move control assembly through stage access door. Lower control assembly onto protective pad.

l. Remove chain-hoist from hoist.

m. Position hoist at track station 7.5 for engine positions 1 through 4, and track station 25 for engine position 5 and connect handler to boom.

n. Remove closures, as required during installation, to initiate connections.

o. Secure electrical control assembly to brackets and rod with washers, bolts, spacers, and nuts. Torque nuts until a 0.001- to 0.003-inch gap exists between nut and spacer. (See figure 3-3.)

p. Remove handler from electrical control assembly.

q. Disassemble track. (Refer to section II.)

NOTE

To prevent corrosion, steps r through ak must be completed within 24 hours.

r. Using adhesive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each igniter cable bell housing flange. Clean bonding surfaces of ground cable, igniter cable bell housing, and mating surfaces without damaging sealing surfaces.

s. Connect ground cable to bracket on thrust chamber with screw and washer. Torque screw to 27-33 inch-pounds.

t. Lubricate bolts that attach augmented spark igniter cables to electrical control assembly with sealing compound.

u. Lubricate augmented spark igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

v. Install augmented spark igniter cables on electrical control assembly and secure with bolts. Install bolts cleaned for bonding in holes

with surrounding area cleaned for bonding. Tighten bolts fingertight.

w. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire. To minimize the need to disassemble due to augmented spark igniter cable leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

x. Install support clamps on augmented spark igniter cable pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 inch-pounds.

y. Connect electrical connectors P1, P2, and P3.

z. Lubricate bolts that attach gas generator spark igniter cables to electrical control assembly with sealing compound.

aa. Lubricate gas generator igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

ab. Install gas generator igniter cables on electrical control assembly with 2 bolts. Tighten bolts fingertight.

ac. Position bracket on igniter cable pressurizing tube bosses and secure bracket and igniter cable bell housing to electrical control assembly with bolts. Tighten bolts fingertight.

ad. Install remaining bolts in igniter cable bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ae. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire.

af. Install washers and nuts on igniter cable pressurizing tube bosses. Torque nuts to 150-200 inch-pounds and safetywire.

ag. Lubricate pressurizing valve O-ring seals for static service with FS1281 grease and install on valves.

ah. Install pressurizing valves in pressurizing tube bosses. Torque valves to 100-120 inch-pounds; after a minimum of 30 minutes, retorque to 100-120 inch-pounds and safetywire.

ai. Measure inherent resistance from electrical control assembly to thrust chamber ground cable and from each igniter cable bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above inherent resistance from electrical control assembly to thrust chamber ground cable.

aj. Apply a coating of lacquer premixed with blue dye to all bonding bolts and connections.

ak. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

al. Refer to R-3825-3 for post-maintenance tests.

3-15. REMOVING ELECTRICAL CONTROL ASSEMBLY (SIVB STAGE).

a. Assemble track for electrical control assembly removal, as required for applicable stage. (Refer to section II.) Install turntable with controls leading.

b. Obtain the following special tools:

(1) Sequence controller handler 9016789

(2) Extension 9027080 from Engine Components Installer G4072. shelf 5

(3) Sleeve 9027084 (SIB vehicle) or 9027084-11 (SV vehicle) from Engine Components Installer G4072, shelf 3

(4) Component handler universal lifting sling 9016779

(5) Component handling cart 9026253 from engine components installer set 9026252

(6) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

(7) Corrosion-preventive compound (MIL-C-11796, Class 3)

c. Obtain closures, or suitable equivalent, electrical connectors. Closures must be certified clean for propellant system use. (Refer to R-3825-4 for closures.)

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements.

(1) Installing closures

(2) Disconnecting electrical connectors

e. Measure pressure in igniter cables as outlined in R-3825-1B; then depressurize igniter cable by backing off pressurizing valve locknut (see figure 3-3) 1-3 turns and depressing valve core.

WARNING

Applying electrical power to the engine when connecting or disconnecting electrical connectors and/or igniter cables or when igniter cables are disconnected can cause electrical arcing, resulting in injury to personnel and damage to equipment.

. Make sure all electrical power to engine is turned off.

g. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses and install closures on all open ports.

CAUTION

Care must be taken throughout the following procedures not to bend the igniter cable pressurizing tube since damage can result.

h. Remove bolts that secure pressurizing valve mounting bracket to bell housing of gas generator igniter cables and remove bracket.

i. Remove remaining bolts that attach gas generator igniter cables to electrical control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on the cable bell housing can damage the igniter cable and electrical control assembly.

j. Remove gas generator igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step k immediately.

k. Install support ST3950166RKL001 and closures on igniter NA5-27448 as follows: (Install protective closures only on all other igniter cables and exciters.)

(1) Inspect interior of bell housing, to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbored holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

l. Install closures on igniter cables 651389 and 651390 and on exciters.

m. Temporarily secure cables to engine.

n. Disconnect electrical connectors P1, P2, and P3.

o. Remove nuts, washers, and screws from augmented spark igniter cable pressurizing tube support clamps.

p. Remove bolts that secure augmented spark igniter cables to control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on the cable bell housing can damage the igniter cable and electrical control assembly.

q. Remove augmented spark igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step r immediately.

r. Install support ST3950166RKL001 and closure on igniter cable NA5-27448 as follows: (Install closures only on all other igniter cables and on exciters.)

(1) Inspect interior of bell housing, to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbored holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

s. Temporarily secure cables to engine.

t. Disconnect ground cable from bracket on thrust chamber.

u. Install sleeve, extension, and handler on hoist. (See figure 3-2, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

v. Manipulate hoist to lower handler, through opening in which lower work platform is installed and orient handler with electrical control assembly.

w. Attach handler on electrical control assembly. (See figure 3-3.) Wrap handler strap around package and secure with ball-lock pin. On engines incorporating MD224 or MD249 change, take care not to damage insulation on electrical control assembly.

CAUTION

Whenever the turnbuckle is adjusting in the following procedure, a minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

x. Support electrical control assembly by manipulation of hoist and turnbuckle on extension. If turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel. Remove nuts, spacers, washers, and bolts that secure electrical control assembly to thrust chamber and rod. Make sure side load does not exist on electrical control assembly.

y. Make sure electrical control assembly is free of engine; then, with hoist and extension turnbuckle, move electrical control assembly clear of engine and through opening in which lower work platform is installed. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in raising component through stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the electrical control assembly to the stage work platform; therefore, it may be necessary for a technician to guide the assembly and assist the hoist operator.

z. If reinstallation will not be completed within 24 hours, coat all bonding surfaces with corrosion-preventive compound.

aa. Using hoist, move electrical control assembly to an accessible area near stage access door.

ab. Remove handler (with electrical control assembly attached) from hoist and temporarily place on protective pad. Install component handler universal lifting sling on handler and secure with ball-lock pin.

NOTE

The combined weight of electrical control assembly, sling, and handler is approximately 70 pounds.

ac. Using lifting eye on sling, manually transport electrical control assembly through stage access door and place control assembly into component handling cart.

3-16. INSTALLING ELECTRICAL CONTROL ASSEMBLY (SIVB STAGE).

a. Obtain the following special tools and materials:

(1) Sequence controller handler 9016789

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(4) Component handler universal lifting sling 9016779

(5) Component handling cart 9026253 from engine components installer set 9026252

(6) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch umbilical arm)

(7) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

(8) Torque wrench capable of torquing to 15-42 inch-pounds

(9) Torque wrench capable of torquing to 100-200 inch-pounds

(10) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(11) Sealing compound RB0140-005 (Rocketdyne)

(12) Abrasive cloth, 320-grit or finer

(13) FS1281 grease (Dow Corning Corp)

b. When accomplishing the following task, refer to R-3825-3 for information:

(1) Connecting electrical connectors

(2) Torquing

(3) Safetywiring

NOTE

The combined weight of the handler, sling, and electrical control assembly is approximately 70 pounds.

WARNING

Applying electrical power to the engine when connecting or disconnecting electrical connectors and/or igniter cables or when igniter cables are disconnected can cause electrical arcing, resulting in injury to personnel and damage to equipment.

c. Using cart, transport electrical control assembly to stage. Transfer control assembly into stage and place on protective pad. A suggested method of handling electrical control assembly is as follows:

(1) Install handler on electrical control assembly. (See figure 3-3.) The engaging lug FLANGE SIDE must be located between gas generator igniter cable receptacle G3 and electrical control assembly support bracket.

(2) Wrap handler straps around electrical control assembly and secure with ball-lock pin. On engines incorporating MD224 or MD249 change, take care not to damage electrical control assembly insulation.

(3) Attach component handler universal lifting sling on handler and secure with ball-lock pin.

d. Make sure all electrical power to the engine is turned off.

e. Before installing electrical control assembly, visually inspect threads in parent metal and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

f. Before installing electrical control assembly, inspect each exciter output adapter for bent or broken contacts as follows: (See figure 3-3.)

(1) Contacts bent less than 0.070 inch from normal position are acceptable; do not attempt to straighten.

(2) Contacts bent 0.070 inch or more from normal position must be broken off (bend contact back and forth) and discarded.

(3) Adapters that have no more than 2 broken contacts (any position) are acceptable.

(4) If any one adapter has more than 2 broken contacts, replace electrical control assembly.

g. Install sleeve and extension on hoist. (See figure 3-2, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series vehicle) from turnbuckle. Secure with ball-lock pin.

h. Install handler on hoist extension. If handler is installed on electrical control assembly (step c), remove sling. If handler is not installed, install handler as outlined in step c, except do not install sling.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

i. Using hoist, move electrical control assembly to and lower through opening in which lower work platform is installed, and position on engine. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in lowering component through stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the electrical control assembly to the engine; therefore, it may be necessary for a technician to guide the assembly and to assist the hoist operator.

j. Remove protective closures, as required during installation, to initiate connections.

k. Secure electrical control assembly to brackets and rod with washers, bolts, spacers, and nuts. Torque nuts until a 0.001- to 0.003-inch gap exists between nut and spacer. (See figure 3-3.)

l. Disconnect hoist, and remove handler from electrical control assembly and extension from hoist.

m. Disassemble track. (Refer to section II.)

NOTE

To prevent corrosion, steps n through af must be completed within 24 hours.

n. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each igniter cable bell housing flange. Clean bonding surfaces of ground cable, igniter cable bell housing, and mating surfaces without damaging sealing surfaces.

o. Connect ground cable to bracket on thrust chamber with screw and washer. Torque screw to 27-33 inch-pounds.

p. Lubricate bolts that attach augmented spark igniter cables to electrical control assembly with sealing compound.

q. Lubricate augmented spark igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

r. Install augmented spark igniter cables on electrical control assembly and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

s. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire. To minimize the need to disassemble due to augmented spark igniter cable leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedure.)

t. Install support clamps on augmented spark igniter cable pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 inch-pounds.

u. Connect electrical connectors P1, P2, d P3.

v. Lubricate bolts that attach gas generator spark igniter cables to electrical control assembly with sealing compound.

w. Lubricate gas generator igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

x. Install gas generator igniter cables on electrical control assembly with 2 bolts. Tighten bolts fingertight.

y. Position bracket on igniter cable pressurizing tube bosses and secure bracket and igniter cable bell housing to electrical control assembly with bolts. Tighten bolts fingertight.

z. Install remaining bolts in igniter cable bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

aa. Cross-torque bolts that secure igniter cables to electrical control assembly in the lowing sequence: 15, 25, and 35 inch-pounds. peat cross-torque to 35 inch-pounds and safetywire.

ab. Install washers and nuts on igniter cable pressurizing tube bosses. Torque nuts to 150-200 inch-pounds and safetywire.

ac. Lubricate pressurizing valve O-ring seals for static service with FS1281 grease and install on valves.

ad. Install pressurizing valves in pressurizing tube bosses. Torque valves to 100-120 inch-pounds; after a minimum of 30 minutes, retorque to 100-120 inch-pounds and safetywire.

ae. Measure inherent resistance from electrical control assembly to thrust chamber ground cable and from each igniter cable bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above inherent resistance from electrical control assembly to thrust chamber ground cable.

af. Apply a coating of lacquer premixed h blue dye to all bonding bolts and nections.

ag. Leak test and pressurize igniter cables. (Refer to R-3825-1B.)

ah. Refer to R-3825-3 for post-maintenance tests.

3-17. FUEL INLET DUCT.

3-18. The fuel inlet duct may be replaced on SII stage engine positions 1 through 4 and on the SIVB stage engine without affecting engine calibration.

3-19. REMOVING FUEL INLET DUCT (SII STAGE). This procedure is for removing fuel inlet duct from engine positions 1 through 4 only. Remove the fuel inlet duct from engine position 5 in accordance with applicable stage procedures.

a. Assemble track (refer to section II) around engine positions (1 through 4) from which inlet duct is to be removed. Install turntable with controls trailing and position hoist at track station 4.5.

b. Obtain the following equipment: (Items 4 through 7 are not required, if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Component handler adapter 9027174, from Engine Components Installer G4071, shelf 2

(2) Fuel inlet duct handler 9016784

(3) Adapter T-5040045

(4) Chain hoist 9027095 from engine components installer set 9026251

(5) Component handler universal lifting sling 9016779

(6) Universal joint S8 from engine components installer set 9026251

(7) Extension bar SX-24 from engine components installer set 9026251

(8) Component handling cart 9026253 from engine components installer set 9026251

(9) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

c. Install handler adapter on hoist in position shown in figure 3-2, view F.

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

e. Using adapter, remove all but 3 bolts that secure duct to turbopump. Leave one bolt in each area between bipods.

f. On engines not incorporating MD233 change, support transducer and bracket.

g. On engines not incorporating MD287 change, temporarily remove vent port check valves from fuel inlet duct and install fittings AN814-12CL with existing gaskets RD261-6001-0001 to seal openings.

h. Install fuel inlet duct handler with adapter socket positioned in direction of track station 7 as follows:

(1) Rotate knurled nuts (2 places) to retract supports

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) With handler oriented with adapter socket toward electrical control assembly, place handler on duct, making sure notches in top and bottom end plates engage lugs at bipod attach fittings.

(5) Move slide arm into position; secure with ball-lock pin.

(6) Rotate and secure pivoted lock

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

i. Remove remaining bolts that secure duct to customer-connect flange, using applicable procedures.

j. Compress duct to maximum allowed by handler.

k. Remove seal at customer-connect flange.

l. Attach hoist to fuel inlet duct handler and secure with ball-lock pin.

m. Remove remaining bolts that secure duct to turbopump.

WARNING

The turbopump inducer extends into the duct 4 inches and can be damaged if struck.

n. Operate hoist to raise duct clear of inducer shroud and engine, taking care not to bump or otherwise damage sealing surfaces.

o. Remove seal between turbopump and duct.

p. Install closures on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps r through v; otherwise, omit step q.

q. Using hoist, transfer duct through stage access door and lower into component handling cart.

r. Using hoist, transfer duct by stage access door and place on protective pad.

s. Attach component handler universal lifting sling to handler on duct.

t. Remove handler adapter from hoist boom and install chain-hoist.

u. Attach hook of hoist to sling and raise duct.

v. Move duct through stage access door and lower into component handling cart.

3-20. INSTALLING FUEL INLET DUCT (SII STAGE). This procedure is for installing fuel inlet duct on engine positions 1 through 4 only. Install fuel inlet duct on engine position 5 in accordance with applicable stage procedures.

a. Obtain the following equipment: (Items 5 through 8 are not required if the launch tower

umbilical arm is to be used for transporting t omponent to the stage.)

(1) Torque wrench, capable of torquing to 175-210 inch-pounds

(2) Fuel inlet duct handler 9016784

(3) Component handler adapter 9027174 from Engine Components Installer G4071, shelf 2

(4) Torque wrench adapter T-5040045

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Component handler universal lifting sling 9016779

(7) Universal joint S8 from engine components installer set 9026251

(8) Extension bar SX-24 from engine components installer set 9026251

(9) Component handling cart 9026253 from e e components installer set 9026251

(10) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

b. Check fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-3.

c. Prior to installation of fuel inlet duct, visually inspect threads in parent metal for damage and/or threaded inserts for damage and correct installation. (Refer to R-3825-3.)

d. If installed, temporarily remove vent port check valves from fuel inlet duct and install fittings AN814-12CL with existing gaskets RD261-6001-0001 to seal openings.

e. Install handler on fuel inlet duct as follows:

(1) Rotate knurled nuts (2 places), to r .ct supports.

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured, to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) Place handler on duct, positioning handler with adapter socket approximately 70 degrees counterclockwise from alinement pin on fuel inlet duct turbopump flange.

NOTE

The counterclockwise position is as viewed from the turbopump end of the duct.

(5) Move slide arm into position and secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

f. Compress fuel inlet duct to maximum allowed by handler.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into stage, omit steps g through l.

g. Install component handler universal lifting sling on duct handler and secure with ball-lock pin.

h. Position hoist on track near stage access door, and install chain-hoist on hoist boom.

i. Move hoist boom through stage access door, and lower hoist hook and attach to sling lifting ring.

j. Raise duct and transfer through stage access door, and place duct on protective pad.

k. Remove sling from duct handler.

l. Remove chain-hoist from hoist boom.

m. Install adapter on hoist boom in position shown in figure 3-2, view F.

n. Connect handler to boom and position hoist at track station 4.5.

o. During installation, remove closures, as required to make connections.

p. Carefully place seal on fuel turbopump inlet flange.

q. Using hoist, move fuel inlet duct into position on engine and aline fuel inlet duct flange pin with hole in fuel turbopump inlet flange. Take care not to allow fuel inlet duct to contact inducer shroud or to bump or otherwise damage seal.

r. Using hoist, lower fuel inlet duct onto fuel turbopump inlet flange. Install a minimum of 3 equally spaced bolts. Tighten bolts sufficiently to prevent relative movement between duct and turbopump.

s. Remove handler from fuel inlet duct.

t. Disassemble track. (Refer to section II.)

u. Secure fuel inlet duct to customer-connect flange, using applicable stage procedures.

v. When torquing, refer to R-3825-3.

w. On engines incorporating MD233 change, secure fuel inlet duct to turbopump inlet flange with dry-film lubricated bolts RD111-1009-3619 and washers. Using torque wrench adapter, cross-torque bolts to 190-210 inch-pounds and safetywire.

x. On engines not incorporating MD287 change, removing fittings AN814-12CL from vent ports, and reinstall vent port check valves using new gaskets RD261-6001-0001. Torque vent port check valves to 175-200 inch-pounds.

y. On engines not incorporating MD233 change, install transducer support bracket and secure with 4 dry-film lubricated bolts RD111-1009-3621 and washers. Install remaining dry-film lubricated bolts and washers, to secure fuel inlet duct to turbopump inlet flange. Using torque wrench adapter, cross-torque bolts to 190-210 inch-pounds and safetywire.

z. Check alinement of fuel inlet duct null-point index mark scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement exceeds 0.066 inch. If duct misalinement exceeds 0.066 inch, aline duct in accordance with procedures in R-3825-3.

aa. Refer to R-3825-3 for post-maintenance test.

3-21. REMOVING FUEL INLET DUCT (SIVB STAGE).

a. Assemble track for fuel inlet duct removal, as required for applicable stage. (Refer to section II.) Install turntable with controls trailing.

b. Obtain the following equipment:

(1) Fuel inlet duct handler 9016784

(2) Adapter T-5040045

(3) Inlet duct support frame installing tool kit 9025150

(4) Spacer, 2 ±1/8 inches thick (spacer required to keep duct in a compressed attitude to permit installation of handler. Configuration of spacer must allow insertion at customer-connect flange. Spacer may be made of any material that will not cause contamination or damage sealing surfaces, and can withstand duct compression forces of 480 pounds (maximum) per inch of duct compression).

(5) Component handling cart 9026253 from engine components installer set 9026252

(6) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

c. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

d. On engines not incorporating MD287 change, temporarily remove vent port check valves from fuel duct and install fittings AN814-12CL with existing gaskets RD261-6001-0001 to seal openings.

e. Remove seal bleed plug and ground strap at fuel inlet duct turbopump flange.

f. Using adapter, remove bolts that secure to customer-connect flange.

g. Install 3 turnbuckles from inlet duct support frame installing tool kit on duct.

h. Compress duct a minimum of 2-1/4 inches and remove seal; then insert spacer between customer-connect flange and duct.

i. Extend and remove turnbuckles from duct.

j. Using adapter, remove all but 3 bolts that secure duct to turbopump. Leave one bolt in each area between bipods.

k. On engines not incorporating MD233 change, support transducer and bracket.

l. Install handler on hoist with end marked TANK END up; then, using hoist to manipulate handler, attach handler to duct as follows:

(1) Rotate knurled nuts (2 places) to retract supports.

(2) At end of handler marked TANK END, e sure pivoted lock is rotated and secured, to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) With handler oriented with adapter socket toward electrical control assembly, place handler on duct, making sure notches in top and bottom end plates engage lugs at bipod attach fittings.

(5) Move slide arm into position; secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

m. Compress duct to maximum allowed by handler.

n. Remove spacer, and install temporary closure (vinyl sheet) on duct opening.

Remove remaining 3 bolts that secure duct to turbopump.

WARNING

The turbopump inducer extends into the duct 4 inches and can be damaged if struck.

NOTE

The inlet duct should move outward and upward on a line radially from the engine axis. The boom head will have to be rotated, to rotate the duct counterclockwise along its vertical axis.

p. Operate hoist to raise duct clear of inducer shroud, taking care not to bump or otherwise damage sealing surfaces.

q. Remove seal between turbopump and duct.

r. Install closures on all open ports. (Refer to R-3825-3.)

s. Using hoist, move fuel inlet duct to an accessible area near stage access door.

NOTE

The weight of the fuel inlet duct is 111 pounds, or 136 pounds if the Haynes 25 (L605) bellows are incorporated.

t. Remove fuel inlet duct from handler. Manually transport duct through stage access door and place duct into components handling cart. If fuel inlet duct was removed to remove fuel turbopump, inlet duct may remain within stage if placed on a protective pad.

3-22. INSTALLING FUEL INLET DUCT (SIVB STAGE).

a. Obtain the following equipment:

(1) Torque wrench, capable of torquing to 175-210 inch-pounds

(2) Fuel inlet duct handler 9016784

(3) Adapter T-5040045

(4) Inlet duct support frame installing tool kit 9025150

(5) Spacer, 2 ±1/8 inches thick (Spacer is required to keep duct in compressed attitude to permit removal of handler. Configuration of

spacer must allow insertion at customer-connect flange. Spacer may be made of any material that will not cause contamination or damage sealing surfaces and can withstand duct compression forces of 480 pounds (maximum) per inch of duct compression.)

(6) Component handling cart 9026253 from engine components installer set 9026252

(7) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Torquing

(2) Safetywiring

c. If fuel inlet duct is outside of stage, manually transport duct to stage, using cart and transfer duct into stage. Place duct on protective pad in an area accessible to hoist.

NOTE

Steps d and e may be accomplished prior to moving the fuel inlet duct into the stage.

d. Check alinement of fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct alinement exceeds 0.066 inch, aline duct in accordance with procedures in R-3825-3.

e. Prior to installation of fuel inlet duct, visually inspect threads in parent metal for damage and/or threaded inserts for damage or correct installation. (Refer to R-3825-3.)

f. If installed, temporarily remove vent port check valves from fuel inlet duct, and install fittings AN814-12CL with existing gaskets RD261-6001-0001, to seal openings.

g. Install handler on fuel inlet duct as follows:

(1) Rotate knurled nuts (2 places) to retract supports.

(2) At end of handler marked TANK END, make sure pivoted lock is rotated and secured, to prevent obstruction of handler opening.

(3) Place slide arm in extreme outward position and secure with ball-lock pin.

(4) Place handler on duct, positioning handler with adapter socket approximately 70 degrees counterclockwise from alinement pin on fuel inlet duct turbopump flange.

NOTE

The counterclockwise position is as viewed from the turbopump end of the duct.

(5) Move slide arm into position and secure with ball-lock pin.

(6) Rotate and secure pivoted lock.

(7) Extend supports by rotating knurled nuts until positive engagement is made with duct.

h. Compress fuel inlet duct to maximum allowed by handler.

i. Connect handler to hoist, and, using hoist, orient duct for installation. To properly orient duct, position hoist so that boom extends toward fuel turbopump from electrical control assembly side of engine.

j. During installation, remove closures, as required to make connections.

k. Carefully place seal on fuel turbopump inlet flange.

l. Using hoist, move fuel inlet duct into position on engine, and aline fuel inlet duct flange pin with hole in fuel turbopump inlet flange. Take care not to allow fuel inlet duct to contact turbopump inducer shroud or to bump or otherwise damage seal.

m. Using hoist, lower fuel inlet duct onto fuel turbopump inlet flange. Install a minimum of 3 equally spaced bolts. Tighten bolts sufficiently, to prevent relative movement between duct and turbopump.

n. Remove closure from top of inlet duct and customer fuel port.

Place spacer on inlet duct flange, and ease tension on inlet duct bellows by extending handler.

p. Remove handler from duct, using hoist to support weight of handler.

q. Install 3 turnbuckles, from inlet duct support frame installing tool kit, on duct.

r. Using turnbuckles, compress duct sufficiently to loosen spacer. Remove spacer.

s. Carefully place seal on inlet flange, alining holes.

t. Extend and remove turnbuckles from duct.

u. Disassemble track. (Refer to section II.)

v. Secure fuel inlet duct to customer-connect flange, using applicable stage procedures.

w. On engines incorporating MD233 change, secure fuel inlet duct to turbopump inlet flange dry-film lubricated bolts RD111-1009- and washers. Using torque wrench adapter, cross-torque bolts to 190-210 inch-pounds and safetywire.

x. On engines not incorporating MD287 change, remove fittings AN814-12CL from vent ports, and reinstall vent port check valves using new gaskets RD261-6001-0001. Torque vent port check valves to 175-210 inch-pounds.

y. On engines not incorporating MD233 change, install transducer support bracket and secure with 4 dry-film lubricated bolts RD111-1009-3621 and washers. Install remaining dry-film lubricated bolts and washers, to secure fuel inlet duct to turbopump inlet flange. Using torque wrench adapter, cross-torque bolts to 190-210 inch-pounds and safetywire.

z. Check alinement of fuel inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct misalinement exceeds 0.066 inch, aline duct in accordance with procedures in F 25-3.

aa. Refer to R-3825-3 for post-maintenance tests.

3-23. FUEL HIGH-PRESSURE DUCT.

3-24. The fuel high-pressure duct may be replaced without affecting engine calibration.

3-25. REMOVING FUEL HIGH-PRESSURE DUCT (SII STAGE).

a. Assemble track (refer to section II) around engine from which fuel high-pressure duct is removed. Install turntable with controls leading for engine positions 1 through 4, and trailing for engine position 5. Position hoist at track station 9 for engine positions 1 through 4, or track station 23 for engine position 5.

b. Obtain the following equipment: (Items 4 through 7 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Fuel feed system handler 9016787-11

(2) Component handling angle adapter 9027172 from Engine Components Installer G4071, shelf 2

(3) Single Head Special Tool Kit G3127

(4) Component handler universal lifting sling 9016779

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Universal joint S8 from engine components installer set 9026251

(7) Extension bar SX-24 from engine components installer set 9026251

(8) Component handling cart 9026253 from engine components installer set 9026251

(9) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

c. Install angle adapter on boom as shown in figure 3-2, view E.

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

e. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Cutting tubes

(3) Disconnecting electrical connectors

f. Remove hardware securing fuel bootstrap hose assembly to fuel duct. (See figure 3-4.)

g. Remove bleed valve from fast shutdown valve.

h. Using tube cutter from Single Head Special Tool Kit G3127, cut fuel pump discharge pressure tube.

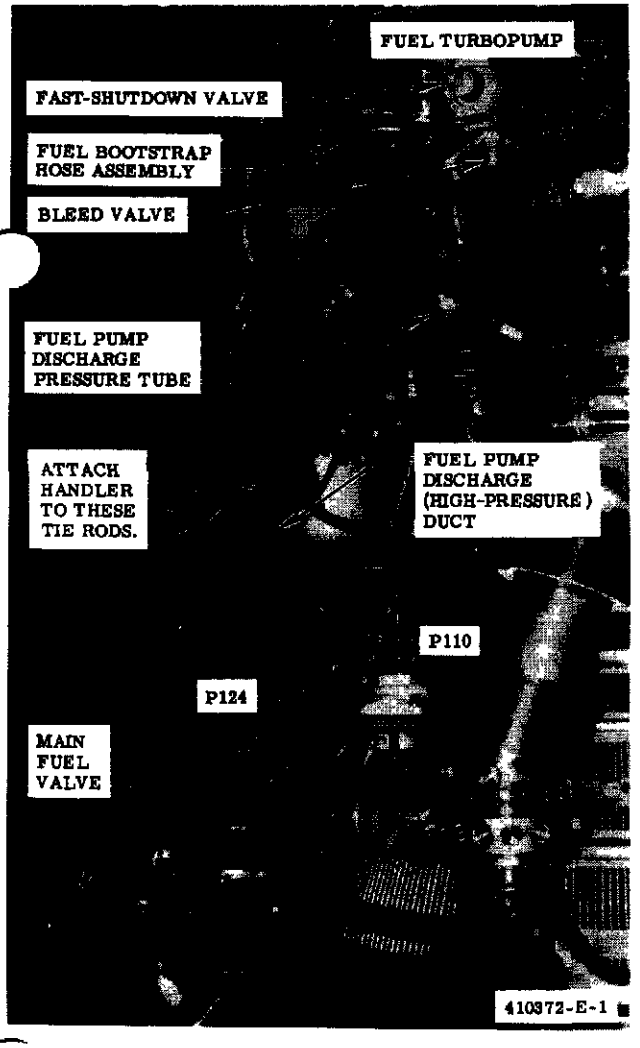


Figure 3-4. Fuel High-Pressure Duct

i. Disconnect electrical connectors P110 and P124.

j. Remove all but 2 equally spaced bolts from flanges connecting duct to turbopump and main fuel valve.

k. Remove any remaining stage installed equipment or instrumentation lines attached to or interfering with duct removal, using applicable procedures.

l. Install fuel feed system handler on fuel duct. Handler attaches to the 2 outboard tie rods with web strap of handler up, securing fuel bootstrap hose.

m. Attach boom to handler and secure with ball-lock pin.

n. Support weight of fuel duct with hoist and remove remaining bolts that secure duct to turbopump and main fuel valve. Should binding bolts be encountered, loosening tie rods may eliminate binding.

o. Move duct clear of engine.

p. Remove seals and install closures.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps r through v; otherwise, omit step q.

q. Using hoist, transfer duct through stage access door and lower on to component handling cart.

r. Using hoist, move duct to an accessible area near stage access door and place duct on protective pad.

s. Install sling on handler and secure with ball-lock pin.

t. Remove adapter and install chain-hoist.

u. Attach hook of hoist to the sling and slowly lift duct.

v. Move duct through stage access door and lower on to component handling cart.

3-[illegible] INSTALLING FUEL HIGH-PRESSURE DUCT (SII STAGE).

a. Obtain the following equipment: (Items 6 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Fuel feed system handler 9016787-11

(2) Torque wrench, capable of torquing to 361-399 inch-pounds

(3) Torque wrench, capable of torquing to 68-157 inch-pounds

(4) Single Head Special Tool Kit G3127

(5) Automatic Inert Gas Arc Welding Set G3128

(6) Component handler universal lifting sling 9016779

(7) Chain-hoist 9027095 from engine components installer set 9026251

Universal joint S8 from engine components installer set 9026251

(9) Extension bar SX-24 from engine components installer set 9026251

(10) Component handling cart 9026253 from engine components installer set 9026251

(11) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Welding tubes

(3) Connecting connectors

(4) Torquing

(5) Safetywiring

c. Before installing high-pressure fuel duct, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

d. Attach handler to fuel duct. (See figure 3-4 for identification of rods to which handler is attached.) Secure the bootstrap hose assembly from movement with the handler strap assembly.

NOTE

If the launch tower umbilical arm is to be used for transporting the component to the stage, omit steps e through j.

e. Install component handler universal lifting sling on duct handler and secure with ball-lock pin.

f. Position hoist on track near stage access door and install chain-hoist on hoist boom.

g. Move hoist boom through stage access door and lower hoist hook and attach to sling lifting ring.

h. Raise duct and transfer duct through stage access door and place duct on protective pad.

i. Remove sling from duct handler.

j. Remove chain-hoist from hoist boom.

k. Install angle adapter on hoist boom in position as shown in figure 3-2, view E, and secure with ball-lock pin. Attach hoist boom to duct handler.

l. Suspend duct over track so that duct is opposite turntable controls.

m. Position hoist at track station 23 for engine positions 1 through 4, or track station 9 for engine position 5. Remove closures, as necessary during installation, to make connections.

n. Position duct on engine and install seals and attaching hardware at main fuel valve. Do not tighten bolts.

o. Check for misalinement of duct and turbopump flanges. Should misalinement exist, the duct may be extended a maximum of 0.5 inch or compressed a maximum of 0.75 inch to effect alinement. Duct can be extended during installation by tightening flange bolts. Make sure tie rods are loosened sufficiently to permit duct extension. Compress duct by shortening tie rods.

p. Install seals, spacers, and attaching hardware securing duct and fast-shutdown valve mounting bracket to turbopump flange.

q. Cross-torque bolts that secure duct to main fuel valve to 605-669 inch-pounds and safetywire.

r. Cross-torque bolts that secure duct and fast-shutdown valve to turbopump to 361-399 inch-pounds and safetywire.

s. Disconnect handler from duct and move handler clear of engine.

t. Make sure tie rods are loose.

u. Adjust the 3 tie rods so that with nut at one end of rod snug, a 0.025-inch feeler gage is a snug fit at opposite end.

v. Pre-load duct by holding tie rod nut on one end and tightening nut on opposite end exactly 3 revolutions. Perform this operation on all tie rods.

w. Safetywire tie-rod nuts to tie rods.

x. Install seal and secure fuel feed line to discharge duct with bolts and washers. Cross-torque bolts to 143-157 inch-pounds and safetywire.

y. Check torque of fuel turbopump discharge pressure tube adapter. Torque must be 68-73 inch-pounds. If torque is low, remove adapter, and replace seal, reinstall adapter, and torque adapter to 68-73 inch-pounds.

z. Install vent port check valve. (Refer to R-3825-3.)

aa. Weld fuel turbopump discharge pressure tube.

ab. Connect electrical connectors P110 and P124.

ac. Refer to R-3825-3 for post-maintenance test.

3-27. REMOVING FUEL HIGH-PRESSURE DUCT (SIVB STAGE).

a. Assemble track (refer to section II for fuel high-pressure duct removal, as required for applicable stage). Install turntable with controls leading.

b. Obtain the following equipment:

(1) Fuel feed system handler 9016787-11

(2) Single Head Special Tool Kit G3127

(3) Extension 9027080 from Engine Components Installer G4072, shelf 5

(4) Sleeve 9027084 from Engine Components Installer G4072, shelf 3

(5) Component handling cart 9026253 from engine component installer set 9026252

(6) Ramp 9026255 from engine component installer set 9026252 (three required for use on launch tower umbilical arm)

c. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

(3) Cutting tubes

e. Remove hardware that secures fuel bootstrap hose assembly to fuel duct. (See figure 3-4.)

f. Remove bleed valve from fast-shutdown valve.

g. Using tube cutter from Single Head Special Tool Kit G3127, cut fuel pump discharge pressure tube.

h. Disconnect electrical connectors P110 and P124.

i. Remove all but 2 equally spaced bolts from flanges that connect duct to turbopump and main fuel valve.

j. Remove any remaining stage installed equipment or instrumentation lines attached to

or interfering with duct removal, using applicable stage procedures.

k. Install sleeve, extension, and handler on hoist. (See figure 3-2, view G.) Position extension in 8th positioning hole (500-series stage) or 9th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pins.

l. Manipulate hoist to lower handler through opening in which access work platform is installed, and orient handler with fuel high-pressure duct.

m. Install handler on fuel duct. Handler attaches to the 2 outboard tie rods with strap of handler up, securing fuel bootstrap hose.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

n. Support weight of fuel high-pressure duct by manipulation of hoist and turnbuckle on extension. If turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel.

o. Remove remaining bolts that secure duct to turbopump and main fuel valve. Should binding bolts be encountered, loosening tie rods may eliminate binding.

p. Move duct clear of engine, remove seals, and install closures.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

q. Using hoist and extension turnbuckle, move fuel high-pressure duct through opening in which access work platform is installed. Do not extend extension turnbuckle beyond maximum length (one thread in adjusting barrel evident).

NOTE

The hoist operator may not have adequate visibility to safely manipulate the fuel high-pressure duct to the stage work deck; therefore, it may be necessary for a technician to guide the duct and to assist the hoist operator.

r. Using hoist, move fuel high-pressure duct to an accessible area near stage access door.

s. Remove fuel high-pressure duct from handler and temporarily place duct on protective pad.

t. Manually carry fuel high-pressure duct through stage access door and place in component handling cart. A suggested method of handling the duct is to attach slings 6001-5-3 at each end of fuel high-pressure duct. Install slings between tie rods around duct, using a choker hitch.

NOTE

The weight of the fuel high-pressure duct is 74 pounds.

3-28. INSTALLING FUEL HIGH-PRESSURE DUCT (SIVB STAGE).

a. Obtain the following equipment:

(1) Fuel feed system handler 9016787-11

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (200-series vehicle) or 9027084-11 (500-series vehicle) from Engine Components Installer G4072, shelf 3

(4) Torque wrench capable of torquing to 361-699 inch-pounds

(5) Torque wrench capable of torquing to 68-157 inch-pounds

(6) Single Head Special Tool Kit G3127

(7) Automatic Inert Gas Arc Welding Set G3128

(8) Component handling cart 9026253 from engine components installer set 9026252

(9) Ramp 9026252 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

c. Using component handling cart, transport fuel high-pressure duct to stage. Transfer duct into stage and place on protective pad. A suggested method of handling the duct is to attach a sling 6001-5-3 at each end of duct with sling installed between tie rods around duct, using a choker hitch.

NOTE

The fuel high-pressure duct weighs 74 pounds.

d. Install sleeve and extension on hoist. (See figure 3-2, view G.) Position extension in 8th positioning hole (500-series stage) or in 9th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

e. Install handler on hoist extension. Secure with ball-lock pin. Install handler with web strap uppermost.

f. Before installing fuel high-pressure duct, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

g. Attach handler to fuel duct. (See figure 3-4 for identification of rods to which handler is attached.) Secure the bootstrap hose assembly from movement with the handler strap assembly.

h. Using hoist, move fuel high-pressure duct to engine position. Suspend duct over track so that duct is opposite turntable controls.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

i. Lower fuel high-pressure duct through opening in which lower platform is installed. If turnbuckle is extended to position duct during lowering, do not extend it beyond a minimum of one thread evident in turnbuckle barrel.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the fuel high-pressure duct to the engine; therefore, it may be necessary for a technician to guide the duct and to assist the hoist operator.

j. Remove closures, as necessary, during installation, to make connections.

k. Position fuel duct on engine and install seals and attaching hardware at main fuel valve. Do not tighten bolts.

l. Check for misalinement of fuel duct and turbopump flanges. Should misalinement exist, the duct may be extended a maximum of 0.5 inch or compressed a maximum of 0.75 inch to effect alinement. Duct can be extended during installation by tightening flange bolts. Make sure tie rods are loosened sufficiently to permit duct extension. Compress duct by shortening tie rods.

m. Install seals, spacers, and attaching hardware securing duct and fast-shutdown valve mounting bracket to turbopump flange.

n. Cross-torque bolts that secure duct to main fuel valve to 605-669 inch-pounds and safetywire.

o. Cross-torque bolts that secure duct and fast-shutdown valve to turbopump to 361-399 inch-pounds and safetywire.

p. Disconnect handler from duct, and move handler clear of engine. Remove handler, extension, and sleeve from hoist.

q. Disassemble track. (Refer to section II.)

r. Make sure tie rods are loose.

s. Adjust the 3 tie rods so that with nut at one end of rod snug, a 0.025-inch feeler gage is a snug fit at opposite end.

t. Pre-load duct by holding tie rod nut on one end and tightening nut on opposite end exactly 3 revolutions. Perform this operation on all tie rods.

u. Safetywire tie-rod nuts to tie rods.

v. Install seal and secure fuel feed line to discharge duct with bolts and washers. Cross-torque bolts to 143-157 inch-pounds and safetywire.

w. Check torque of fuel turbopump discharge pressure tube adapter. Torque must be 68-73 inch-pounds. If torque is low, remove adapter and replace seal, reinstall adapter, and torque adapter to 68-73 inch-pounds.

x. Install vent port check valve. (Refer to R-3825-3.)

y. Weld fuel turbopump discharge pressure e.

z. Connect electrical connectors P110 and P124.

aa. Refer to R-3825-3 for post-maintenance tests.

3-29. FUEL TURBINE EXHAUST DUCT.

3-30. The fuel turbine exhaust duct may be replaced without affecting engine calibration.

3-31. REMOVING FUEL TURBINE EXHAUST DUCT (SII STAGE).

a. Assemble track (refer to section II) around engine position from which turbine duct is to be removed. If task is to be performed on engine position 5 (center), install heat shield support turnbuckle. (Refer to section II.) Install turntable with controls trailing for engine positions 1 through 4, and leading for engine position 5. Position hoist 26-30 inches prior to track station 1 for engine positions 1 through 4, and at track station 2 for engine position 5.

b. Obtain the following equipment: (Items 3 through 6 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Fuel exhaust duct handler 9025874, from Engine Components Installer G4071, shelf 3

(2) Sling 6001-5-5, from Engine Components Installer G4071, shelf 3

(3) Component handler universal lifting sling 9016779

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Components handling cart 9026253 from engine components installer set 9026251

(8) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(9) Bypass valve actuation plate kit 9016723-11

(10) Bypass valve removal tool kit 9020269.

(11) Torque wrench, capable of torquing to 68-82 inch-pounds

(12) Torque wrench, capable of torquing to 135-185 inch-pounds.

(13) Source of pressurized helium, capable of supplying regulated pressure to a minimum of 425 psig and capable of being connected to a 1/4-inch AN male fitting

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Torquing

(3) Disconnecting connectors

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.)

e. Remove all but 3 equally spaced bolts from flanges that secure turbine duct to fuel turbopump, oxidizer turbopump, and oxidizer turbine bypass valve. Make sure the 3 bolts adjacent to the 1/4-inch tapped holes in the flange at the bypass valve are removed.

f. Disconnect electrical connector P117 from bypass valve.

g. Disconnect bypass valve opening control line, remove seal and orifice, and install protective closures (refer to R-3825-3) on all open ports.

h. Disconnect bypass valve closing control line, remove seal, and install closures on closing control line.

i. Install test plate 9020251-11 from actuation plate kit on bypass valve closing control port. Torque bolts that secure test plate to 41-45 inch-pounds.

j. Install bypass valve removal tool (figure 3-5). Torque bolts to 68-82 inch-pounds.

k. Connect source of regulated helium pressure to test plate on closing control port. Torque coupling nut to 135-185 inch-pounds.

l. Close bypass valve by applying 400 ±25 psig to closing control port.

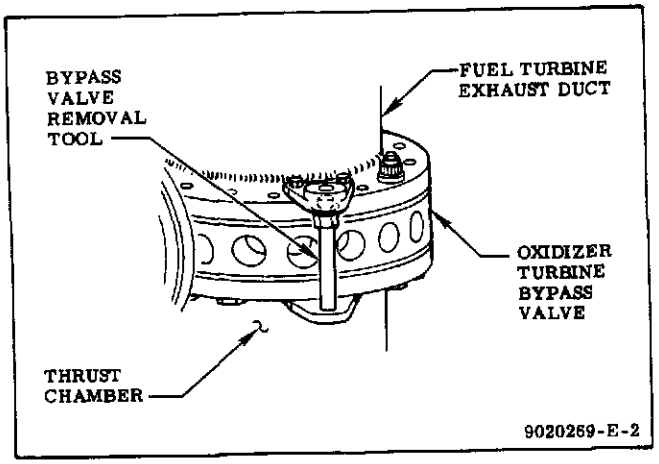


Figure 3-5. Bypass Valve Removal Tool Installed

CAUTION

Valve must be closed during removal. to prevent damage to orifice nozzle or valve gate.

m. Remove remaining bolts that secure bypass valve.

n. Separate flange on either side of bypass valve sufficiently, to remove bypass valve and seals. Flanges are separated by rotating hex nut on removal tool.

o. Remove bypass valve and seals.

p. Install closures on bypass valve, fuel turbine exhaust duct, and thrust chamber.

q. Relieve pressure to bypass valve. If regulating system does not relieve trapped pressure, open manual bleed valve on test plate.

r. Relieve pressure applied by bypass valve removal tool and remove tool from flange.

s. Install handler and sling on fuel turbine exhaust duct (figure 3-6).

t. Attach boom to handler and secure with ball-lock pin.

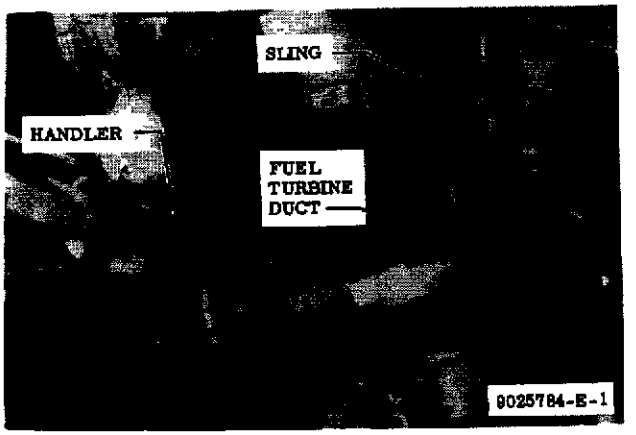


Figure 3-6. Handler and Sling Installed on Fuel Turbine Exhaust Duct

u. Support weight of duct at fuel turbopump with hoist and remove remaining bolts that secure duct to fuel turbopump.

CAUTION

Manually restrain movement of exhaust duct, to prevent damage to duct or engine.

v. Support weight of duct at oxidizer turbopump manually by using sling, and remove remaining bolts that secure duct to oxidizer turbopump.

w. Move duct clear of engine and install closures on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit step y through ab; otherwise, omit step x.

x. Using hoist, transfer duct through stage access door and lower on to component handling cart.

y. Using hoist, transfer duct by stage access door and place duct on protective pad.

z. Install component handler universal lifting sling on handler.

aa. Install chain-hoist on boom and attach hook to sling.

ab. Using hoist, slowly raise and transfer duct through stage access door and lower on to component handling cart. Guide duct through door and on to cart using sling 6001-5-5.

3-32. INSTALLING FUEL TURBINE EXHAUST DUCT (SII STAGE).

a. Obtain the following equipment: (Items 7 through 10 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Torque wrench, capable of torquing to 41-152 inch-pounds

(2) Fuel exhaust duct handler 9025874 from Engine Components Installer G4071, shelf 3

(3) Sling 6001-5-5 from Engine Components Installer G4071, shelf 3

(4) Bypass valve actuation plate kit 9016723-11

(5) Bypass valve removal tool kit 9020269

(6) Source of pressurized helium, capable of supplying regulated pressure to a minimum of 425 psig and capable of being connected to 1/4-inch AN male fitting.

(7) Component handler universal lifting sling 9016779

(8) Chain-hoist 9027095 from engine components installer set 9026251

(9) Universal joint S8 from engine components installer set 9026251

(10) Extension bar SX-24 from engine components installer set 9026251

(11) Components handling cart 9026253 from engine components installer set 9026251

(12) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Connecting electrical connectors

(3) Torquing

(4) Safetywiring

c. Remove closures, as required during installation, to make connections.

d. Before installing fuel turbine exhaust duct, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

e. Install handler and sling on fuel turbine exhaust duct (figure 3-6).

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps f through k.

f. Install sling on duct handler and secure with ball-lock pin.

g. Position hoist near stage access door and install chain-hoist on hoist boom.

h. Move hoist boom through stage access door and lower hoist hook and attach to sling lifting ring.

i. Raise duct and guide with sling 6001-5-5 and transfer duct through stage access door and place duct on protective pad.

j. Remove sling from duct handler.

k. Remove chain-hoist from hoist boom.

CAUTION

Manually restrain movement of exhaust duct, to prevent damage to duct or engine.

l. Attach boom to handler and secure with ball-lock pin.

m. Position hoist 26-30 inches prior to track station 1 for engine positions 1 through 4, and at track station 2 for engine position 5.

n. Support weight of duct at fuel turbopump with hoist and weight of duct at oxidizer turbopump manually, by using sling, and move fuel turbine exhaust duct into position on engine.

o. Place seal between flanges of fuel turbopump and fuel turbine exhaust duct and temporarily secure with 4 diametrically opposite bolts, nuts, and washers. Do not torque bolts at this time.

p. Place seal between flanges of fuel turbine exhaust duct and oxidizer turbopump. Temporarily secure with 4 diametrically opposite bolts, nuts, and washers. Do not torque bolts at this time.

q. Remove sling and handler from fuel turbine exhaust duct.

r. Disassemble track. (Refer to section II.)

s. If task is being performed on engine position 5 (center), remove heat shield support turnbuckle and reinstall heat shield V-strut (stage) in accordance with applicable stage procedures.

t. Install remaining bolts, washers, nuts, and brackets to secure fuel turbine exhaust duct to fuel turbopump. Cross-torque bolts to 138-152 inch-pounds.

u. Install remaining bolts, nuts, washers, and brackets to secure fuel turbine exhaust duct to oxidizer turbopump. Cross-torque bolts to 119-131 inch-pounds.

v. Install bypass valve removal tool (figure 3-5). Torque bolts to 68-82 inch-pounds.

w. Rotate hex until fuel turbine exhaust duct bellows are compressed enough to allow valve and seals to be installed.

x. Remove closures from bypass valve and install test plate 9020251-11 from actuation plate kit on bypass valve closing control port.

y. Connect a pressure hose between test plate and a regulated pneumatic source of helium capable of supplying 425 psig.

z. Apply 400 ±25 psig to actuator control port. Bypass valve closes. The valve must be in a closed position for installation.

aa. Install and position bypass valve and seals, using bolts for alinement.

ab. Rotate hex to allow fuel turbine exhaust duct bellows to expand into position.

ac. Remove brackets and install remaining bolts, washers, and nuts. Insert bolts from thrust chamber side, except for one bolt on inboard side of duct (next to drain boss) which must be installed from exhaust duct side. Cross-torque nuts to 76-84 inch-pounds.

ad. Reduce pneumatic pressure to valve closing control port. Open bleed valve on test plate and vent pressure. Remove pressure hose and test plate.

ae. Install seal on bypass valve closing control port and connect closing control line to closing control port with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

af. Install orifice and seal, and connect opening control line to bypass valve opening control port with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

ag. Install electrical connector P117.

ah. Refer to R-3825-3 for post-maintenance test.

3-33. REMOVING FUEL TURBINE EXHAUST DUCT (SIVB STAGE).

a. Locate applicable illustration showing required track for removal of fuel turbine exhaust duct (refer to installing track and hoist, section II) and install access work platform where shown in illustration.

b. Obtain the following equipment:

(1) Fuel exhaust duct handler 9025874 from Engine Components Installer G4072, shelf 3

(2) Sling 6001-5-5 from Engine Components Installer G4072, shelf 3

(3) Extension 9027080 from Engine Components Installer G4072, shelf 5

(4) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(5) Bypass valve actuation plate kit 9016723-11

(6) Bypass valve removal tool kit 9020269

(7) Torque wrench capable of torquing to 41-82 inch-pounds

(8) Torque wrench capable of torquing to 135-185 inch-pounds

(9) Source of pressurized helium capable supplying regulated pressure to a minimum of 425 psig and capable of being connected to a 1/4-inch AN male fitting.

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

d. Obtain closures, or suitable equivalents, for removal of exhaust ducts. (Refer to R-3825-4.)

e. Attach sling to fuel turbine exhaust duct. (See figure 3-6.) Secure sling to prevent movement of duct.

f. Remove bolts, washers, brackets, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. Remove seal.

g. Remove access work platform, and close stage work deck.

h. Assemble track (refer to section II) for fuel turbine exhaust duct removal, as required for applicable vehicle. Install turntable with controls trailing.

i. Remove all but 3 equally spaced bolts from flanges that secure fuel turbine exhaust duct to fuel turbopump and oxidizer turbine bypass valve. Make sure the 3 bolts adjacent to 1/4-inch tapped holes in flange at bypass valve are removed.

j. Disconnect electrical connector P117 from bypass valve.

k. Disconnect bypass valve opening control line, remove seal and orifice, and install closures on all open ports.

l. Disconnect bypass valve closing control line, remove seal, and install closures on closing control line.

m. Install test plate 9020251-11 from bypass valve actuation plate kit on bypass valve closing control port. Torque bolts that secure test plate to 41-45 inch-pounds.

n. Install bypass valve removal tool (figure 3-5). Torque bolts to 68-82 inch-pounds.

o. Connect source of regulated helium pressure to test plate on closing control port. Torque coupling nut to 135-185 inch-pounds.

p. Close bypass valve by applying 400 ±25 psig to closing control port.

CAUTION

The valve must be closed during removal, to prevent damage to the orifice nozzle or valve gate.

q. Remove remaining bolts that secure bypass valve.

r. Separate flange on either side of bypass valve sufficiently to remove bypass valve and seals. Flanges are separated by rotating hex nut on removal tool.

s. Remove bypass valve and seals.

t. Install closures on bypass valve, fuel turbine exhaust duct, and thrust chamber.

u. Relieve pressure to bypass valve. If regulating system does not relieve trapped pressure, open manual bleed valve on test plate.

v. Relieve pressure applied by bypass valve removal tool and remove tool from flange.

w. Install sleeve, extension, and handler on hoist. (See figure 3-2, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pin.

x. Manipulate hoist to lower handler through opening in which lower work platform is installed and orient handler with fuel turbine exhaust duct. (See figure 3-6.)

y. Attach handler to fuel turbine exhaust duct. Wrap handler straps around duct and secure.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

z. Support weight of duct at fuel turbopump by manipulation of hoist and turnbuckle on extension. If turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel. Make sure side load does not exist on duct.

aa. Remove remaining bolts that secure duct to fuel turbopump. Remove seal.

ab. Manually support end of fuel turbine exhaust duct near oxidizer turbopump and move fuel turbine exhaust duct, manually and with hoist, clear of engine. Install protective closures.

ac. Remove pie-shaped sections of stage work deck. (See figure illustrating track configuration for identification of pie-shaped sections in section II).

NOTE

While removing the fuel turbine exhaust duct (step ad), the access work platform may be temporarily removed to gain additional clearance.

ad. Move fuel turbine exhaust duct toward end of track and raise duct through opening provided by removal of pie-shaped sections of stage work deck.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

ae. Using hoist, sling, and extension turnbuckle, raise fuel turbine exhaust duct through opening provided by the removal of stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the duct to the stage work deck; therefore, it may be necessary for a technician to guide the duct and to assist the hoist operator.

CAUTION

The duct must be manually supported with the sling when transferring duct with the hoist, to prevent damage to the duct due to the excessive length.

af. Using hoist and sling, move duct to an accessible area near stage access door. Manually

port duct during transfer using sling attached to duct.

ag. Remove duct from hoist and temporarily place on protective pad.

CAUTION

Care must be used when handling the duct, to prevent unnecessary flexing of the bellows, which can damage the duct.

ah. Manually carry duct from stage. A suggested method of handling the duct is to attach slings 6001-5-3 to duct using a choker hitch.

NOTE

The weight of the fuel turbine exhaust duct is 73 pounds.

3-34. INSTALLING FUEL TURBINE EXHAUST DUCT (SIVB STAGE).

a. Obtain the following equipment:

(1) Torque wrench capable of torquing to 152 inch-pounds

(2) Fuel exhaust duct handler 9025874 from Engine Components Installer G4072, shelf 3

(3) Sling 6001-5-5 from Engine Components Installer G4072, shelf 3

(4) Extension 9027080 from Engine Components Installer G4072, shelf 5

(5) Sleeve 9027084 (SIB vehicle) or 9027084-11 (SV vehicle) from Engine Components Installer G4072, shelf 3

(6) Bypass valve actuation plate kit 9016723-11

(7) Bypass valve removal tool kit 9020269

(8) Source of pressurized helium capable of supplying regulated pressure to a minimum of 425 psig and capable of being connected to 1/4-inch AN male fitting

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Torquing

(3) Safetywiring

CAUTION

Care must be used when handling the duct, to prevent unnecessary flexing of the bellows, which can damage duct.

c. Manually carry fuel turbine exhaust duct into vehicle and place on protective pad. A suggested method of handling the duct is to attach slings 6001-5-3 to duct using a choker hitch.

NOTE

The weight of the fuel turbine exhaust duct is 73 pounds.

d. Install sleeve, extension, and handler on hoist. (See figure 3-2, view G.) Position extension in 5th positioning hole (500-series stage) or 7th positioning hole (200-series stage) from turnbuckle. Secure with ball-lock pins.

e. Install fuel turbine exhaust duct on handler. Wrap handler straps around duct and secure.

f. Attach sling to fuel turbine exhaust duct. (See figure 3-6.)

CAUTION

The duct must be manually supported with the sling when transferring the duct with the hoist, to prevent damage to the duct due to the excessive length.

g. Using hoist and manually supporting duct with sling, move duct to opening provided by removal of stage work deck pie-shaped panels. See figure (section II) that shows applicable track configuration for removing fuel turbine exhaust duct. Manually support duct during transfer using sling attached to duct.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

h. Using hoist and sling, lower duct through opening in stage work deck. Extending turnbuckle to its maximum length (one thread in adjusting barrel evident) will effect a narrow profile to aid in lowering component through stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the fuel turbine exhaust duct to the engine; therefore, it may be necessary for a technician to guide the duct and to assist the hoist operator.

i. Remove closures, as required during installation, to initiate connections.

CAUTION

Movement of the exhaust duct must be manually restrained, to prevent damage to duct or engine.

j. Support weight of duct at fuel turbopump with hoist and weight of duct at oxidizer turbopump manually, by using sling, and move fuel turbine exhaust duct into position on engine. Secure sling to prevent movement of duct at oxidizer turbopump.

k. Place seal between flanges of fuel turbopump and fuel turbine exhaust duct, and install bolts, washers, nuts, and brackets to secure fuel turbine exhaust duct to fuel turbopump. Cross-torque bolts to 138-152 inch-pounds.

l. Install bypass valve removal tool. (See figure 3-5.) Torque bolts to 68-82 inch-pounds.

m. Rotate hex until fuel turbine exhaust duct bellows are compressed enough to allow valve and seals to be installed.

n. Remove closures from bypass valve, and install test plate 9020251-11 from bypass valve actuation plate kit on bypass valve closing control port.

o. Connect a pressure hose between test plate and a regulated pneumatic source of helium capable of supplying 425 psig.

p. Apply 400 ±25 psig to actuator control port. Bypass valve closes. The valve must be in a closed position for installation.

q. Install and position bypass valve and seals, using bolts for alinement.

r. Rotate hex to allow fuel turbine exhaust duct bellows to expand into position.

s. Remove brackets, and install remaining bolts, washers, and nuts. Insert bolts from thrust chamber side, except for one bolt on inboard side of duct (next to drain boss) which must be installed from exhaust duct side. Cross-torque nuts to 76-84 inch-pounds.

t. Reduce pneumatic pressure to valve closing control port. Open bleed valve on test plate and vent pressure. Remove pressure hose and test plate.

u. Install seal on bypass valve closing control port and connect closing control line to closing control port with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

v. Install orifice and seal and connect opening control line to bypass valve opening control port with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

w. Install electrical connector P117. Remove handler from fuel turbine exhaust duct.

x. Remove handler, extension, and sleeve from hoist.

y. Disassemble track. (Refer to section II.)

z. Install work platform adjacent to oxidizer turbopump end of fuel turbine exhaust duct. (Refer to section II.)

aa. Place seal between flanges of fuel turbine exhaust duct and oxidizer turbopump.

ab. Install remaining bolts, nuts, washers, and brackets to secure fuel turbine exhaust duct to oxidizer turbopump. Cross-torque bolts to 119-131 inch-pounds.

ac. Remove sling from fuel turbine exhaust duct.

ad. Refer to R-3825-3 for post-maintenance tests.

3-35. FUEL TURBOPUMP.

3-36. The fuel turbopump may be removed and reinstalled, but not replaced without affecting engine calibration.

3-37. REMOVING FUEL TURBOPUMP (SII STAGE).

a. Assemble track (refer to section II) around engine positions (1 through 5) from which fuel turbopump is to be removed. Install turntable with controls leading, and position hoist at track station 2 for engine positions 1 through 4, or track station 4 for engine position 5.

b. Obtain the following equipment: (Items 5, 6, 7, 10, 11, and 12 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Handler 9026977 from Engine Components Installer G4071, shelf 3

(2) Hook 9024600 from Engine Components Installer G4071, shelf 1

(3) Single Head Special Tool Kit G3127

(4) Torque wrench adapter T-5040045

(5) Hanger 9024543 from engine components installer set 9026251

(6) Pickup adapter 9024547 from engine components installer set 9026251

(7) Chain-hoist 9027095 from engine components installer set 9026251

(8) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(9) Components handling cart 9026253 from engine components installer set 9026251

(10) Universal joint S8, from engine components installer set 9026251

(11) Extension bar SX-24 from engine components installer set 9026251

(12) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

(4) Torquing

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

e. Remove fuel inlet duct (paragraph 3-21) from engine positions 1 through 4, or from engine position 5 using applicable procedures. Install handler on fuel turbopump volute with arrow pointing toward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position. Using torque wrench adapter, cross-torque handler bolts to 190-210 inch-pounds. Install closure RX20714 on handler.

f. Disconnect gas generator control valve (figure 3-7) as follows:

(1) Disconnect electrical connector P116.

(2) Remove bolts and washers that secure bracket and mainstage control manifold to control valve. Remove seal.

(3) Using tube cutter from Single Head Special Tool Kit G3127, cut gas generator pressure equalization line and gas generator oxidizer injector pressure and purge line pressure.

(4) Remove bolts and washers that secure oxidizer and fuel lines to gas generator control valve. Remove orifices and seals.

g. Remove bolts, washers, brackets, and seal that secure start tank discharge valve hose to fuel turbine manifold.

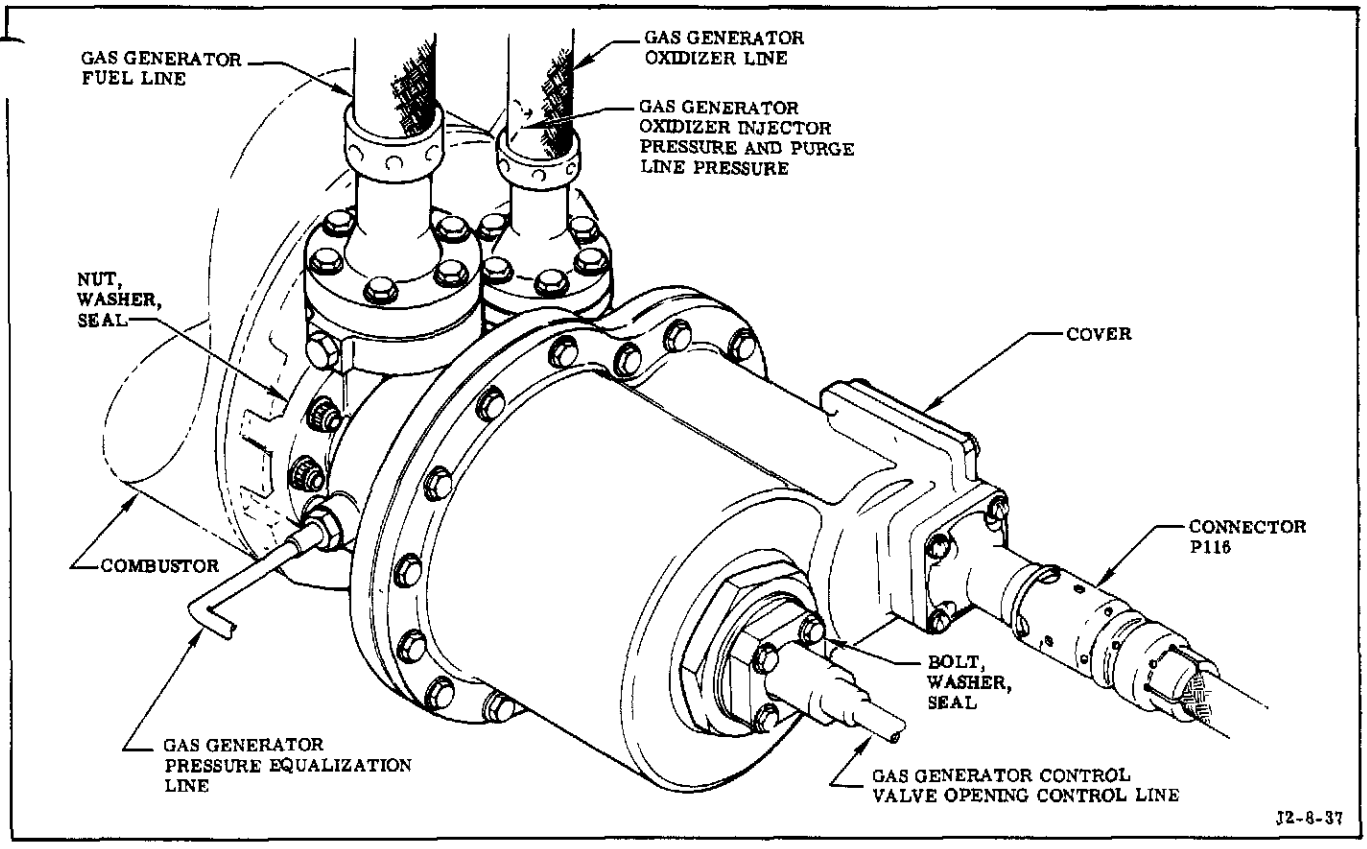


Figure 3-7. Gas Generator Control Valve

h. Remove bolts, washers, and seal that secure fuel high-pressure duct to turbopump fuel volute. (See figure 3-8.)

i. Disconnect gas generator spark igniter cables at electrical control assembly and gas generator combustor. (Refer to R-3825-3.)

j. Disconnect electrical connectors P112, P126, P141, and P161. On engines incorporating MD172 change, temperature probe is removed from turbopump rear bearing and connector P161 is stored. On engines incorporating MD185 change, connector P161 is removed. On engines incorporating MD233 change, connector P141 is removed.

k. Using tube cutters from Single Head Special Tool Kit G3127, cut the following: turbine seal cavity drain line, primary seal cavity drain line, first-stage turbine wheel upstream pressure tube, fuel pump balance piston cavity pressure tube PF5, turbine seal cavity purge line, gas generator fuel injector pressure tube P4, rear bearing support seal bleed line, and gas generator oxidizer injector pressure tube GO5. Cut lines and tubes on engine side of bracket, leaving approximately 3 inches of straight tube on turbopump. (See figure 3-8.)

l. Install hook on hoist as shown in figure 3-2, view A.

NOTE

If the launch tower umbilical arm is to be used for component removal from the stage, omit steps m and n.

m. Install pickup adapter on handler lifting eye.

n. Connect hook on hoist to pickup adapter attached to handler lifting eye on fuel turbopump volute and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

o. Connect hook on boom to handler lifting eye on fuel turbopump volute and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

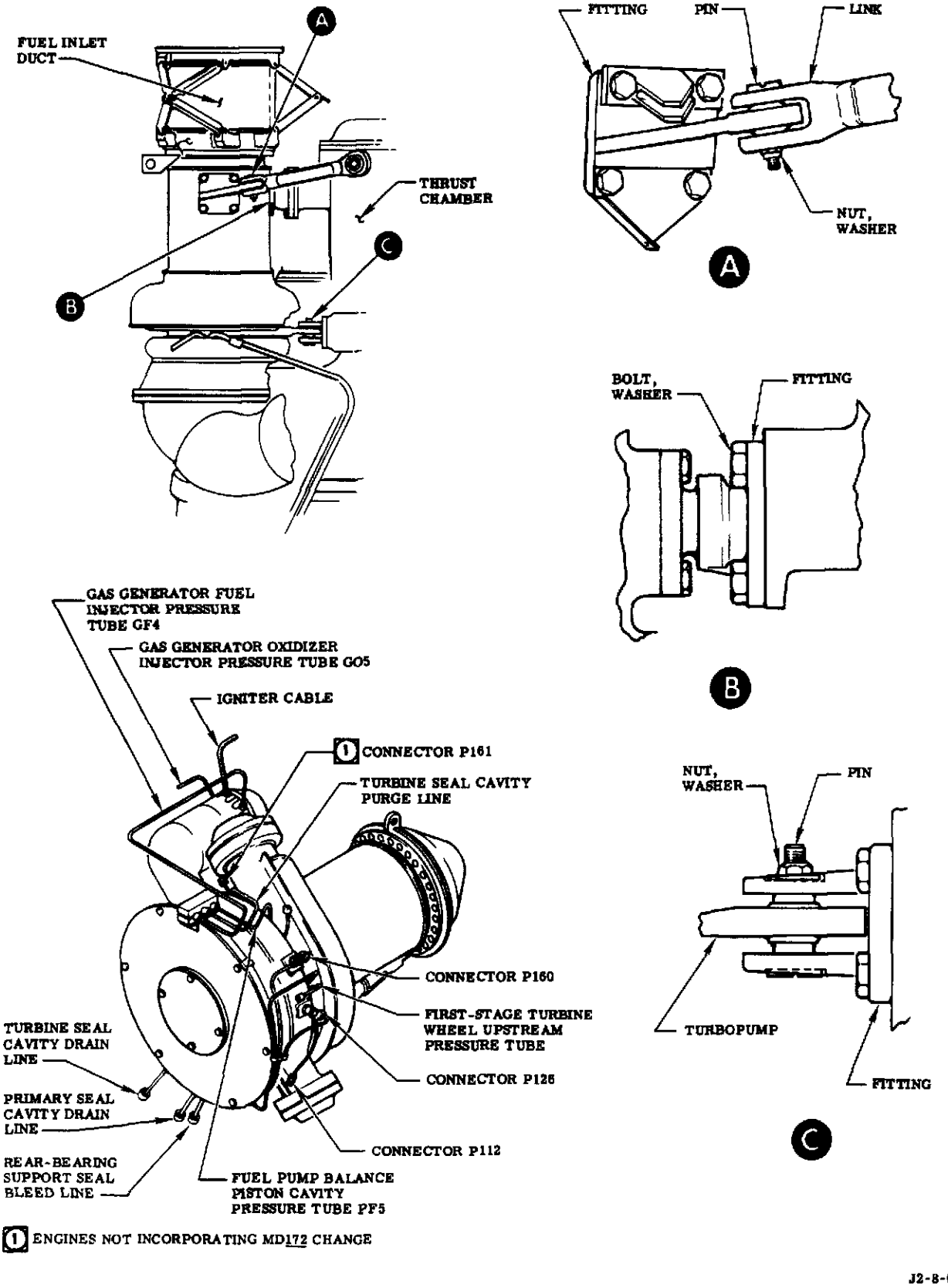


Figure 3-8. Fuel Turbopump

p. Remove bolts, washers, nuts, and brackets that secure fuel turbine exhaust duct to turbopump manifold.

q. Remove lower nut, washer, and pin that secure fuel turbopump to thrust chamber.

r. Remove nut, washer, and pin that secure link to fitting.

s. Remove bolts and washers (on thrust chamber side of fitting) that secure fuel turbopump to thrust chamber.

t. Make sure fuel turbopump is free of engine; then move turbopump clear of engine.

u. Install closure on turbopump and all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting component from stage, omit steps w through ag; otherwise, omit step v.

v. Using hoist, transfer turbopump through stage access door and slowly lower turbopump into component handling cart.

w. Using hoist, slowly move turbopump to hanger and attach to the hanger using the pickup adapter swivel.

x. Remove hook from hoist.

y. Install chain-hoist on hoist boom.

z. Attach hoist hook to the pickup adapter using a shackle and raise turbopump.

aa. Slowly move turbopump through stage access door and lower turbopump into component handling cart.

3-38. INSTALLING FUEL TURBOPUMP (SII STAGE).

a. Obtain the following equipment: (Items 3 through 8 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4071, shelf 3

(2) Hook 9024600 from Engine Components Installer G4071, shelf 1

(3) Hanger 9024543 from engine components installer set 9026251

(4) Pickup adapter 9024547 from engine components installer set 9026251

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(7) Universal joint S8 from engine components installer set 9026251

(8) Extension bar SX-24 from engine components installer set 9026251

(9) Automatic Inert Gas Arc Welding Set G3128

(10) Single Head Special Tool Kit G3127

(11) Torque wrench capable of torquing to 12-80 inch-pounds

(12) Torque wrench capable of torquing to 100-399 inch-pounds

(13) Torque wrench adapter T-5040045

(14) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(15) Components handling cart 9026253 from engine components installer set 9026251

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Connecting electrical connectors

(3) Welding tubes

(4) Torquing

(5) Safetywiring

c. Install handler on fuel turbopump volute. Install handler with arrow pointing toward fuel turbopump attach point and index pin engaging

hole in pump flange. Place lifting eye in fuel turbopump lifting position. Using torque wrench adapter, cross-torque handler attach bolts to 190-210 inch-pounds. Install closure RX20714 on handler.

NOTE

If the launch tower umbilical arm is to be used for transporting components to stage, omit steps d through k; otherwise, omit steps l through n.

d. Install pickup adapter on handler.

e. Position hoist on track near stage access door and install chain-hoist on hoist boom.

f. Move hoist through stage access door and lower hoist hook and attach hoist hook to pickup adapter using a shackle.

g. Slowly raise turbopump and transfer turbopump through stage access door.

h. Move turbopump to hanger and attach turbopump to the hanger using the pickup adapter swivel; secure with ball-lock pin.

i. Remove chain-hoist from hoist boom.

j. Install hook on hoist boom, as shown in figure 3-2, view A.

k. Connect hook on hoist boom to pickup adapter and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

l. Install hook on hoist boom, as shown in figure 3-2, View A.

m. Connect hook on hoist boom to handler lifting eye on fuel turbopump and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

n. Slowly raise turbopump and transfer turbopump through stage access door.

o. Position hoist at track station 2 for engine positions 1 through 4, or track station 4 for engine position 5.

p. Remove closures, as required during installation, to make connections.

q. Before installing fuel turbopump, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

r. Using hoist, move fuel turbopump (figure 3-8) into position on engine.

s. Install washers and bolts securing fitting on turbopump to thrust chamber, as shown in figure 3-8, view B. Do not torque bolts at this time.

t. Install pin, washer, and nut securing link to fitting. Torque nut to 143-157 inch-pounds. If pin does not aline with fitting and link, loosen bolts securing turbopump to thrust chamber, install pin, and then tighten bolts fingertight. Do not torque bolts at this time.

u. Install pin, washer, and nut securing turbopump to thrust chamber. Torque nut to 100-140 inch-pounds. If pin does not aline with turbopump and thrust chamber fittings, loosen bolts securing turbopump to thrust chamber, install pin, and then torque bolts (step s) to 361-399 inch-pounds and safetywire. Remove hook on hoist boom from handler or pickup adapter and move hoist clear of turbopump.

v. Weld turbine seal cavity drain line, primary seal cavity drain line, first-stage turbine wheel upstream pressure tube, fuel pump balance piston cavity pressure tube PF5, turbine seal cavity purge line, gas generator fuel injector pressure tube GF4, rear bearing support seal bleed line, and gas generator oxidizer injector pressure tube GO5. (See figure 3-8.)

w. Connect gas generator spark igniter cables at electrical control assembly and gas generator combustor. (Refer to R-3825-3.)

x. Install seal between fuel turbine manifold and start tank discharge valve hose and secure with bolts and washers. Torque bolts to 285-315 inch-pounds and safetywire.

y. Install seal between fuel high-pressure duct and turbopump fuel volute. Secure with bolts and washers. Torque bolts to 361-399 inch-pounds and safetywire.

z. Install bolts, nuts, washers, and brackets securing fuel turbine exhaust duct to turbopump manifold. Cross-torque bolts to 119-131 inch-pounds.

aa. Connect gas generator control valve (figure 3-7) as follows:

(1) Install seal, mainstage control manifold, and bracket on pneumatic inlet port with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

(2) Install orifice, seals, and oxidizer and fuel feed lines on gas generator control valve with bolts and washers. Torque bolts to 48-52 inch-pounds and safetywire.

(3) Weld gas generator pressure equalization line and gas generator oxidizer injector pressure and purge line pressure.

(4) Connect electrical connector P116.

ab. Remove handler and pickup adapter and install fuel inlet duct (paragraph 3-20) for engine positions 1 through 4, or for engine position 5 using applicable stage procedures.

ac. Connect electrical connectors P112, P126, P141, and P161. On engines incorporating MD172 change, connector P161 is stored. On engines incorporating MD185 change, connector P161 is removed. On engine incorporating MD233 change, connector P141 is removed.

ad. Refer to R-3825-3 for post-maintenance test.

3-39. REMOVING FUEL TURBOPUMP (SIVB STAGE).

a. Assemble track (refer to section II) for fuel turbopump removal, as required for applicable stage. Install turntable with controls leading.

b. Obtain the following equipment:

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Adapter 9026997 from engine components installer set 9026252

(6) Chain-hoist 9027095 from engine components installer set 9026252

(7) Components handling cart 9026253 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Extension bar SX24 from engine components installer set 9026252

(10) Automatic Inert Gas Arc Welding Set G3128

(11) Single Head Special Tool Kit G3127

(12) Torque wrench adapter T-5040045

(13) Torque wrench capable of torquing to 12-70 inch-pounds

(14) Torque wrench capable of torquing to 190-210 inch-pounds

c. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

(3) Cutting tubes

(4) Removing gas generator spark igniter cables

e. Remove fuel inlet duct (paragraph 3-21), except do not install adapter RD395-44094-011 on fuel turbopump volute.

NOTE

It is not necessary to remove the fuel inlet duct from the stage.

f. Install handler 9026977 and adapter 9026997 on fuel turbopump volute as follows:

(1) Install handler with arrow pointing ward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position.

(2) Using torque wrench adapter, cross-torque handler attach bolts to 190-210 inch-pounds.

(3) Remove screws that attach closure RX20714 to handler. Remove closure.

(4) Place adapter on closure and install closure and adapter on handler 9026977. Torque bolts to 50-70 inch-pounds.

(5) Make sure lifting adapter on turbopump adapter is directly above centerline chain fuel turbopump position. Remove ball-lock pin and rotate adapter, if required.

g. Disconnect gas generator control valve (figure 3-7) as follows:

(1) Disconnect electrical connector P116

(2) Remove bolts and washers that secure cket and mainstage control manifold to con- ol valve. Remove seal.

(3) Using tube cutter from Single Head Special Tool Kit G3127, cut gas generator pressure equalization line and gas generator oxidizer injector pressure and purge line pressure line.

(4) Remove bolts and washers that secure oxidizer and fuel feed lines to gas generator control valve. Remove orifices and seals.

h. Remove bolts, washers, and brackets that secure start tank discharge valve hose to fuel turbine manifold. Remove seal.

i. Remove bolts and washers that secure fuel high-pressure duct to turbopump fuel volute. Remove seal. (See figure 3-8.)

j. Disconnect gas generator spark igniter cables. (Refer to R-3825-3.)

k. Disconnect electrical connectors P112, P126, P141, and P161. On engines incorporating MD172 change, temperature probe is oved from turbopump rear bearing and con- ector P161 is stored. On engines incorporating MD185 change, connector P161 is removed. On engines incorporating MD233, MD303, or MD304 change, connector P141 is removed.

l. Using tube cutters from Single Head Special Tool Kit G3127, cut the following: turbine seal cavity drain line, primary seal cavity drain line, first-stage turbine wheel upstream pressure tube, fuel pump balance piston cavity pressure tube PF5, turbine seal cavity purge line, gas generator fuel injector pressure tube GF4, rear-bearing support seal bleed line, and gas generator oxidizer injector pressure tube GO5. Cut lines and tubes on engine side of bracket, leaving approximately 3 inches of straight tube on turbopump.

m. Install hook on hoist, as shown in figure 3-2, view A.

n. Connect pickup adapter on hook lifting and secure hook latch with ball-lock pin. Support turbopump using hoist.

o. Remove bolts, washers, nuts, and brackets that secure fuel turbine exhaust duct to turbopump manifold.

p. Remove lower nut, washer, and pin that secure fuel turbopump to thrust chamber.

q. Remove nut, washer, and pin that secure link to fitting.

r. Remove bolts and washers (on thrust chamber side of fitting) that secure fuel turbopump to thrust chamber.

s. Make sure fuel turbopump is free of engine; then move turbopump clear of engine.

t. Install closure on turbopump and all open ports.

u. Assemble hanger in accessible area near stage access door.

v. Using hoist, move turbopump to hanger.

CAUTION

Raising the hoist boom above the indicated maximum height can damage equipment.

w. Raise hoist until pickup adapter engages hanger shackle. Do not raise hoist above the indicated maximum height. If pickup adapter

does not engage hanger shackle with hoist adjusted to maximum, adjust boom turnbuckle until pickup adapter engages hanger shackle.

x. Remove ball-lock pin from hook and remove hoist from hanger.

y. Assemble elevated track (refer to section II) for removal of fuel turbopump from stage.

z. Install chain-hoist on hoist and secure with ball-lock pin.

aa. Loosen internal wrenching bolt, and remove hook from chain-hoist.

ab. Move hoist into position to pick up fuel turbopump.

ac. Make sure lifting adapter on turbopump adapter 9026997 is installed directly above the centerline chain fuel turbopump position.

ad. Connect chain-hoist chain to lifting adapter and torque internal wrenching bolt to 12-15 inch-pounds.

ae. Using hoist and chain-hoist, remove fuel turbopump from hanger.

CAUTION

The fuel turbopump must be restrained due to the limited access, to prevent damage to the turbopump and stage.

af. Using hoist, move fuel turbopump through stage access door. Manually restrain movement of fuel turbopump when moving it through stage access door.

ag. Using chain-hoist and hoist, lower fuel turbopump to component handling cart.

ah. Install fuel turbopump in component handling cart and remove chain-hoist from handler.

3-40. INSTALLING FUEL TURBOPUMP (SIVB STAGE).

a. Obtain the following equipment:

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Adapter 9026997 from engine components installer set 9026252

(6) Chain-hoist 9027095 from engine components installer set 9026252

(7) Component handling cart 9026253 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Extension bar SX24 from engine components installer set 9026252

(10) Automatic Inert Gas Arc Welding Set G3128

(11) Single Head Special Tool Kit G3127

(12) Torque wrench capable of torquing to 12-80 inch-pounds

(13) Torque wrench capable of torquing to 100-399 inch-pounds

(14) Torque wrench adapter T-5040045

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

(5) Installing gas generator spark igniter cables

c. Prior to installing fuel turbopump, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

d. Install handler and adapter on fuel turbopump volute as follows:

(1) Install handler with arrow pointing toward fuel turbopump attach point and index pin engaging hole in pump flange. Place lifting eye in fuel turbopump lifting position.

(2) Using torque wrench adapter, cross-torque handler attach bolts to 190-210 inch-pounds.

(3) Remove screws that attach closure to handler.

(4) Place adapter on closure, and install closure and adapter on handler. Cross-torque bolts to 50-70 inch-pounds.

(5) Make sure lifting adapter on turbopump adapter is directly above centerline chain fuel turbopump. Remove quick-disconnect pin and rotate adapter, as required.

e. Install chain-hoist on hoist and secure with ball-lock pin.

f. Connect chain-hoist chain-fitting to lifting adapter and torque internal wrenching bolt (on chain fitting) to 12-15 inch-pounds.

g. Using chain-hoist and hoist, raise fuel turbopump from component handling cart.

CAUTION

The fuel turbopump must be restrained due to the limited access, to prevent damage to the fuel turbopump and stage.

h. Using hoist, move fuel turbopump into stage. Manually restrain movement of fuel turbopump when moving it through stage access door.

i. Make sure pickup adapter is attached to hanger.

j. Using hoist, move fuel turbopump to hanger and aline handler lifting eye with pickup adapter.

k. Secure fuel turbopump to hanger with ball-lock pin on pickup adapter.

l. Remove hoist and chain-hoist. Install chain-hoist hook on chain-hoist and torque internal wrenching bolt to 12-15 inch-pounds.

m. Disassemble elevated track, and reassemble lower track. (Refer to section II.)

n. Install hook on hoist. (See figure 3-2, view A.)

o. Position hoist and connect hook to pickup adapter and secure with ball-lock pin.

CAUTION

Raising hoist boom above the indicated maximum height can damage the equipment.

p. Raise hoist and remove fuel turbopump from hanger. Do not raise hoist above indicated maximum height. Adjust boom turnbuckle to obtain additional hoist height.

q. Using hoist, move fuel turbopump (figure 3-8) into position on engine.

r. Remove closures, as required during installation, to make connections.

s. Install washers and bolts securing fitting on turbopump to thrust chamber. Do not torque bolts at this time.

t. Install pin, washer, and nut securing link to fitting. Torque nut to 143-157 inch-pounds. If pin does not aline with fitting and link, loosen bolts that secure turbopump to thrust chamber, install pin, and then tighten bolts fingertight. Do not torque bolts at this time.

u. Install pin, washer, and nut securing turbopump to thrust chamber. Torque nut to 100-140 inch-pounds. If pin does not aline with turbopump and thrust chamber fittings, loosen bolts that secure turbopump to thrust chamber, install pin, and then torque bolts (step s) to 361-399 inch-pounds and safetywire. Remove hoist from handler and move hoist clear of turbopump.

v. Weld turbine seal cavity drain line, primary seal cavity drain line, first-stage turbine wheel upstream pressure tube, fuel pump balance piston cavity pressure tube PF5, turbine seal cavity purge line, gas generator fuel injector pressure tube GF4, rear bearing support

seal bleed line, and gas generator oxidizer injector pressure tube GO5. (See figure 3-8.)

w. Install spark igniter cables and seals in gas generator combustor. If threads of igniter cable have been dry-film lubricated and thread area has a blue-black cast, torque to 60-80 inch-pounds. If threads have not been dry-film lubricated, torque to 100-150 inch-pounds.

x. Connect gas generator spark igniter cables. (Refer to R-3825-3.)

y. Install seal between fuel turbine manifold and start tank discharge valve hose and secure with bolts and washers. Torque bolts to 285-315 inch-pounds and safetywire.

z. Install seal between fuel high-pressure duct and turbopump fuel volute. Secure with bolts and washers. Torque bolts to 361-399 inch-pounds and safetywire.

aa. Install bolts, nuts, washers, and brackets securing fuel turbine exhaust duct to turbopump manifold. Cross-torque bolts to 119-131 inch-pounds.

ab. Connect gas generator control valve (figure 3-7) as follows:

(1) Install seal, mainstage control manifold, and bracket on pneumatic inlet port with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

(2) Install orifice, seals, and oxidizer and fuel feed lines on gas generator control valve with bolts and washers. Torque bolts to 48-52 inch-pounds and safetywire.

(3) Weld gas generator tube equalization line and gas generator oxidizer injector pressure and purge line pressure line.

(4) Connect electrical connector P116.

ac. Remove handler and adapter, and install fuel inlet duct (paragraph 3-22).

ad. Connect electrical connectors P112, P126, P141, and P161. On engines incorporating MD172 change, connector P161 is stored. On engines incorporating MD185 change, connector P161 is removed. On engines incorporating MD233, MD303, or MD304 change, connector P141 is removed.

ae. Refer to R-3825-3 for post-maintenance tests.

3-41. GIMBAL.

3-42. The gimbal may be removed and reinstalled, but not replaced without affecting engine alinement.

3-43. REMOVING GIMBAL (SII STAGE).

a. Assemble track around engine from which gimbal is to be removed. Install turntable with controls leading, and position hoist at track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

b. Obtain the following equipment: (Items 3 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Fluid level, 4-6 inches long

(2) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(3) Engine component handler 9024539 from engine components installer set 9026251

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent.

(8) Hanger 9024543 from engine components installer set 9026251

(9) Pickup adapter 9024547 from engine components installer set 9026251

(10) Components handling cart 9026253 from engine components installer set 9026251

(11) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

c. Remove fuel inlet duct (paragraph 3-19) and oxidizer inlet duct (paragraph 3-61) from engine position (1 through 4) from which gimbal is to be removed. Disconnect inlet ducts for engine position 5, using applicable stage procedures.

d. Remove gimbal boot.

e. Install engine lowering system (refer to section II) for engine from which gimbal is to be removed. Engine must be lowered a minimum of 2.5 inches to accomplish the following procedure.

f. If gimbal is being removed from engine position 5, disconnect from stage and support LOX BLEED LINE, OXIDIZER TANK PRESSURIZATION, FUEL BLEED LINE, and HYDROGEN TANK PRESSURIZATION fluid interface lines. In addition, remove as many clamps as necessary from both the fluid and electrical interface lines, to provide maximum freedom to interface lines and still provide restraint to minimize induced stresses in lines.

g. See figure 3-9 and paint surfaces requiring scribe marks with machinist's blue ink, then scribe gimbal as shown in figure 3-9.

CAUTION

If gimbal adjusting bolt or screw is rotated, the engine requires alinement.

h. Break torque on 4 bolts that secure gimbal to oxidizer dome and loosen each bolt a maximum of one turn. If gimbal adjusting bolt and screw are safetywired to bolts that attach gimbal to injector dome, safetywire to gimbal, taking care not to rotate either bolt or screw.

i. Adjust lower end of both turnbuckles to dimension shown in figure 3-26.

j. Adjust mechanism at top of lowering system to position turnbuckles vertically in 2 planes, 90 degrees apart. Use fluid level.

k. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts to check level of engine.

CAUTION

While the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing lower-end adjustment can induce moments into the turnbuckles that can bend the turnbuckles.

l. Make sure lower end of turnbuckles are positioned to dimension shown in figure 3-26; then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1/16 inch.

m. Slowly lower engine by extending turnbuckles until a 1/4 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

n. Attach a bridle consisting of four 1/2 to 5/8 inch diameter ropes to thrust chamber exit flange. Install and adjust bridle to the following requirements:

(1) Ropes must be attached to the exit flange with 1/4-inch shackles, at 90-degree intervals, and in line with the engine x- and z-axes.

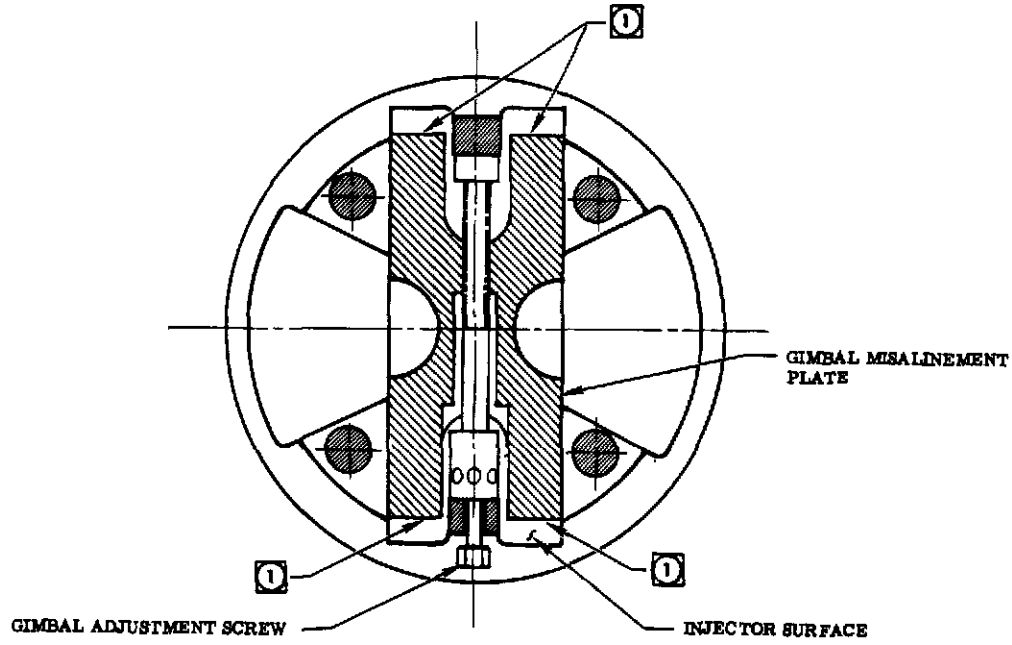
(2) The ropes must be secured to some permanent structure capable of absorbing a minimum of 200-pound side loads and a minimum of 6 feet from the perimeter of the engine exit flange. Ropes, when secured, must be within 10 degrees of horizontal.

(3) The 2 ropes in line with the engine x-axis must be adjusted and tightened, to hold the engine level on the x-axis, with a minimum of 25 pounds tension on the ropes.

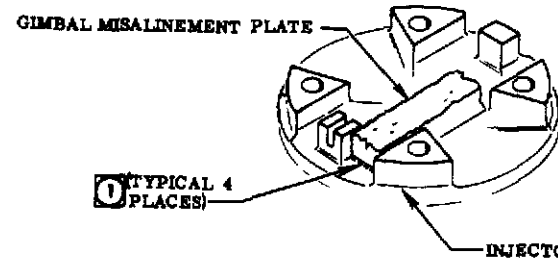
(4) The 2 ropes in line with the engine z-axis must be tightened equally to a minimum of 25 pounds tension.

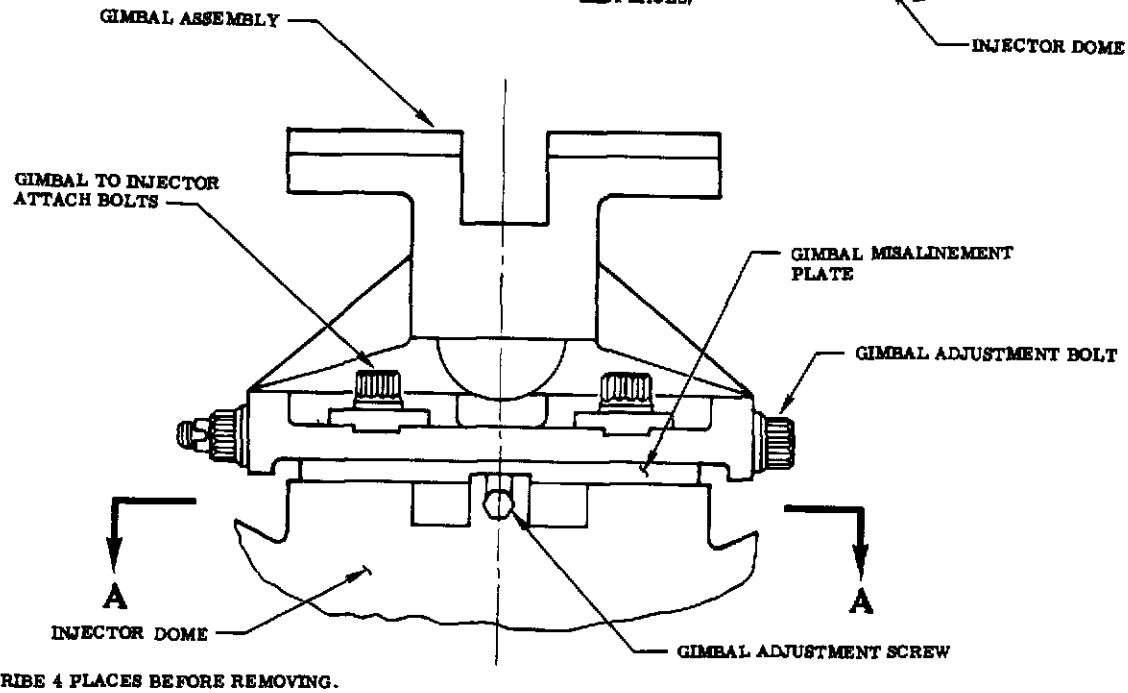
o. Check turnbuckles for being vertical (vertical in 2 planes, 90 degrees apart). If necessary, return them to vertical by adjusting mechanism at top of turnbuckles.

p. Remove nuts and bolts that formerly secured gimbal to stage.



SECTION A-A





1 SCRIBE 4 PLACES BEFORE REMOVING.

208883-E-2

Figure 3-9. Scribing Gimbal for Alinement Control

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering slowly and carefully.

q. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway, at which time, reduce rotation of turnbuckles to 1/6-turn increments until gimbal is clear. Monitor gimbal while lowering, for evidence of binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

r. Lower engine 2 to 2.5 inches by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other; monitor fluid and electrical interface lines, to make sure they do not become taut. If desired, engine may be lowered more than 2.5 inches; however, if 4 inches is to be exceeded, disconnect and support fluid interface lines.

NOTE

One flat of the turnbuckle adjusting barrel may be marked as index to keep count of turnbuckle rotations.

s. Remove bolts that secure gimbal to dome making sure not to damage spark igniter cables.

t. Disassemble handler 9027263 by separating extension from handler. Attach extension to boom and straddle gimbal with handler as shown in figure 3-10. Handler is to be positioned to extend over engine between main oxidizer valve and oxidizer turbopump.

u. Attach boom with extension (step t) to handler. Manipulate hoist to effect as short a coupling between extension and handler portions of handler 9027263 as possible, and pin the 2 parts of handler together.

v. Raise and remove gimbal.

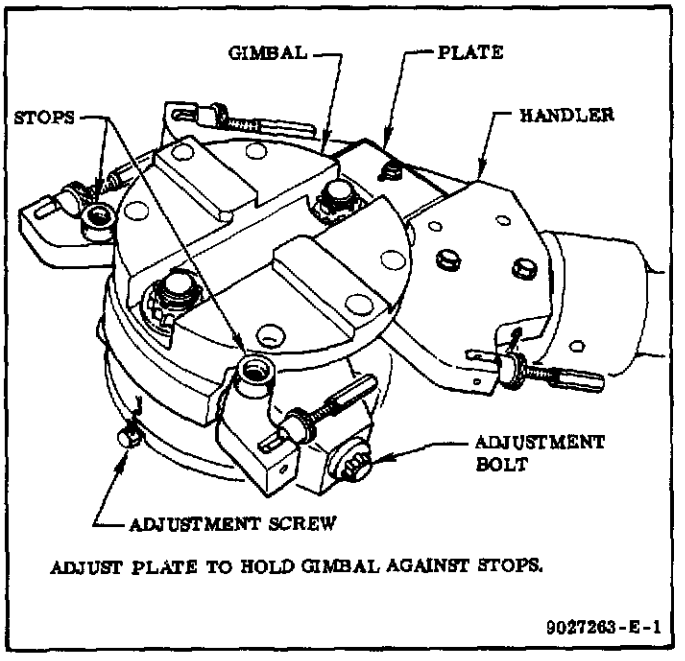


Figure 3-10. Gimbal Handler Installed

NOTE

If the launch tower umbilical arm is to be used for transporting the component from stage, omit steps x through af; otherwise, omit step w.

w. Using hoist, transfer gimbal through stage access door and lower into component handling cart.

x. Place hanger in an accessible area near stage access door and within 35-40 inches of track.

y. Attach pickup adapter to hanger and secure with ball-lock pin.

z. Attach handler 9024539 on cleared area of gimbal using inner bolts and clamping nuts. Torque bolts 145-185 inch-pounds.

aa. Using hoist, transfer gimbal on to hanger. Secure handler 9024539 to pickup adapter with ball-lock pin.

ab. Remove handler 9027263 from hoist boom, and install chain-hoist. Secure with ball-lock pin.

ac. Maintain or note configuration of handler 9027263 for gimbal reinstallation.

ad. Attach shackle to pickup adapter. Do not install shackle in pickup adapter slot.

ae. Connect chain-hoist chain to shackle.

af. Using hoist and chain-hoist, remove gimbal from hanger and transfer gimbal through stage access door. Lower gimbal into component handling cart.

3-44. INSTALLING GIMBAL (SII STAGE).

a. Obtain the following equipment: (Items 3 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Torque wrench, capable of torquing to 45-158 foot-pounds

(2) Gimbal and injector handler 9027263, from Engine Components Installer G4071, shelf 2

(3) Engine component handler 9024539 from engine components installer set 9026251

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(8) Hanger 9024543 from engine components installer set 9026251

(9) Pickup adapter 9024547 from engine components installer set 9026251

(10) Handling cart 9026253 from engine components installer set 9026251

(11) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps d through k; otherwise, omit steps b and c.

b. Secure gimbal in handler 9027263 as shown in figure 3-10; then connect hoist to handler.

c. Raise gimbal and transfer gimbal through stage access door.

d. Install handler 9024539 on gimbal using inner bolts and clamping nuts. Torque bolts to 145-185 inch-pounds.

e. Attach pickup adapter to handler 9024539. Attach shackle to pickup adapter. Do not attach shackle in pickup adapter slot.

f. Position hoist on track near stage access door and install chain-hoist on hoist boom.

g. Move hoist boom through stage access door, and attach chain-hoist hook to shackle.

h. Raise gimbal and transfer gimbal through stage access door. Attach pickup adapter to hanger and secure with ball-lock pin.

i. Install handler 9027263 on gimbal as shown in figure 3-10.

j. Remove chain-hoist from hoist boom, and connect hoist boom to handler on gimbal.

k. Using hoist, remove gimbal from hanger. Remove pickup adapter and handler from gimbal.

NOTE

During the remainder of this procedure, care must be taken when performing tasks near the igniter cables, to prevent damage to igniter cables.

l. Using hoist, place gimbal into position, passing it over engine between oxidizer turbopump and main oxidizer valve, while working turntable toward track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

m. Lower gimbal onto oxidizer injector dome and install eccentric washers and attach bolts. Tighten bolts fingertight.

n. Remove handler 9027263 from gimbal.

o. Raise engine by shortening turnbuckles until gimbal is about to engage stage. Keep engine reasonably level while raising, by maintaining rotation of turnbuckles within one turn of each other.

p. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated by pushing on the engine about the dome area. If, however, there is gross misalinement, level engine and/or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles and/or changing horizontal load at engine exit flange.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustments mechanism at top of turnbuckles. Adjust turnbuckles equally, so that turnbuckles remain parallel to each other.

q. With gimbal alined, raise engine with 1/6-turn increments on turnbuckles until both keyways are engaged.

r. Continue raising engine by shortening turnbuckles, until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage, keep rotation of turnbuckles within one turn of each other.

s. Secure gimbal to stage, using applicable stage procedures.

CAUTION

Thrust chamber can be damaged by striking stage structure.

t. Aline gimbal misalinement plate to scribe marks on oxidizer injector dome (see figure 3-9) and, maintaining alinement, tighten gimbal to oxidizer injector bolts until bolts are seated and sufficiently tight to prevent movement between gimbal and oxidizer injector dome. Restrain engine while tightening bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure.

u. Cross-torque gimbal-to-oxidizer injector dome bolts to 145-158 foot-pounds. Apply torque in a minimum of 3 equal increments. Restrain engine while torquing, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, remove engine lowering system (step x), and then torque the gimbal attach bolts.

v. Safetywire gimbal-to-oxidizer injector dome attach bolts.

w. Remove ropes attached to exit flange.

x. Remove engine lowering system. (Refer to section II.)

y. Install gimbal boot. Torque clamp bolts to 6-8 inch-pounds.

z. Install oxidizer inlet duct (paragraph 3-62) and fuel inlet duct (paragraph 3-20) for engine positions 1 through 4; for engine position 5, install ducts using applicable stage procedures.

aa. If gimbal is being installed on engine position 5, connect the liquid oxygen and liquid hydrogen recirculation bleed lines and the liquid oxygen tank pressurization line.

3-45. REMOVING GIMBAL (SIVB STAGE).

a. Assemble track (refer to section II) for gimbal removal, as required for applicable stage. Install turntable with controls trailing.

b. Obtain the following equipment:

(1) Fluid level, 4-6 inches long

(2) Gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2

c. Remove fuel inlet duct (paragraph 3-21) and oxidizer inlet duct (paragraph 3-63) from engine.

d. Remove gimbal boot.

e. Install engine lowering system. (Refer to section II.) Engine must be lowered a minimum of 2.5 inches, to accomplish the following procedure.

f. See figure 3-9, and paint surfaces requiring scribe marks with machinist's blue ink; then scribe gimbal as shown in figure 3-9.

CAUTION

If the gimbal adjusting bolt or screw is rotated, the engine requires alinement.

g. Break torque on 4 bolts that secure gimbal to oxidizer dome and loosen each bolt a maximum of one turn. If gimbal adjusting bolt and screw are safetywired to bolts that attach gimbal to injector dome, resafetywire bolt and screw to gimbal, taking care not to rotate either bolt or screw.

h. Adjust lower end of both turnbuckles to dimensions shown in figure 3-26.

i. Adjust mechanism at top of lowering system to position turnbuckles vertically in 2 planes, 90 degrees apart. Use fluid level.

j. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts, to check level of engine.

CAUTION

While the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing lower-end adjustment can induce moments into the turnbuckles that can bend the turnbuckles.

k. Make sure lower end of turnbuckles are positioned to dimension shown in figure 3-26; then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1/16 inch.

l. Slowly lower engine by extending turnbuckles until a 1/2 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

m. Attach a bridle consisting of four 1/2 to 5/8 inch diameter ropes to thrust chamber exit flange. Install and adjust bridle to the following requirements:

(1) Ropes must be attached to the exit flange with 1/4-inch shackles, at 90-degree intervals, and in line with the engine X and Z axes.

(2) The ropes must be secured to some permanent structure capable of absorbing a minimum of 200-pound side loads and a minimum of 6 feet from the perimeter of the exit flange. Ropes, when secured, must be within 10 degrees of horizontal.

(3) The 2 ropes in line with the engine x-axis must be adjusted and tightened to hold the engine level on the x-axis, with a minimum of 25 pounds tension on the ropes.

(4) The 2 ropes in line with the engine z-axis must be equally tightened to a minimum of 25 pounds tension.

n. Check turnbuckles for being vertical (vertical in 2 planes, 90 degrees apart). If necessary, return them to vertical by adjusting mechanism at top of turnbuckles.

o. Remove nuts and bolts that formerly secured gimbal to stage.

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering slowly and carefully.

p. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway, at which time, reduce rotation of turnbuckles to 1/6-turn increments until engine is clear. Monitor the gimbal while lowering, for evidence of binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

NOTE

One flat of the turnbuckle adjusting barrel may be marked as an index to keep count of turnbuckle rotations.

q. Lower engine 2-2.5 inches by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other; monitor fluid and electrical interface lines, to make sure they do not become taut. If desired, engine may be lowered more than 2.5 inches; however, if 4 inches is to be exceeded, disconnect and support fluid interface lines.

r. Remove bolts that secure gimbal to dome making sure not to damage augmented spark igniter propellant lines or cables.

s. Attach handler to hoist and extend adapter to the 6th positioning hole. Secure with ball-lock pin.

t. Manipulate hoist and straddle gimbal with adapter as shown in figure 3-10. Handler is to be positioned to extend over engine between main oxidizer valve and oxidizer turbopump.

. Raise and remove gimbal, passing gimbal between oxidizer turbopump and main oxidizer valve.

v. Using hoist, transfer gimbal to stage exit.

w. Remove gimbal from hoist and manually carry gimbal from stage.

3-46. INSTALLING GIMBAL (SIVB STAGE).

a. Obtain the following equipment:

(1) Torque wrench, capable of torquing to 145-158 foot-pounds

(2) Gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2

b. Position hoist with handler installed, in an accessible area near stage access door. Manually carry gimbal into stage and install gimbal in handler as shown in figure 3-10.

CAUTION

During the remainder of this procedure, care must be taken when performing tasks near the augmented spark igniter propellant lines and cables, to prevent damage to propellant lines and cables.

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Torquing

(2) Safetywiring

d. Using hoist, place gimbal into position, passing gimbal between oxidizer turbopump and main oxidizer valve, while working turntable toward main oxidizer valve.

e. Lower gimbal onto oxidizer injector dome and install eccentric washers and bolts. Tighten bolts fingertight.

f. Remove handler from gimbal.

g. Raise engine by shortening turnbuckles until gimbal is about to engage stage. Keep engine reasonably level while raising, by maintaining rotation of turnbuckles within one turn of each other.

h. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated by pushing on the engine about the dome area. If, however, there is gross misalinement, level engine and/or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles and/or changing horizontal load at engine exit flange.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustment mechanisms at top of turnbuckles. Adjust turnbuckles equally so that turnbuckles remain parallel to each other.

i. With gimbal alined, raise engine with 1/6-turn increments on turnbuckles until both keyways are engaged.

j. Continue raising engine by shortening turnbuckles until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage, keep rotation of turnbuckles within one turn of each other.

k. Secure gimbal to stage, using applicable stage procedures.

CAUTION

The thrust chamber can be damaged by striking the stage structure.

l. Aline gimbal misalinement plate to scribe marks on oxidizer injector dome (see figure 3-9), and maintaining alinement, tighten gimbal-to-oxidizer injector bolts until bolts are seated and sufficiently tight to prevent movement between gimbal and oxidizer injector dome. Restrain engine while tightening bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure.

m. Cross-torque gimbal to oxidizer injector dome bolts to 145-158 foot-pounds. Apply torque in a minimum of 3 equal increments. Restrain engine while torquing, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, remove engine lowering system (step p), and then torque gimbal attach bolts.

n. Safetywire gimbal-to-oxidizer injector dome attach bolts.

o. Remove ropes attached to exit flange.

p. Remove engine lowering system. (Refer to section II.)

q. Install gimbal boot. Torque clamp bolts to 6-8 inch-pounds.

r. Install fuel inlet duct (paragraph 3-22) and oxidizer inlet duct (paragraph 3-64).

3-47. HEAT EXCHANGER

3-48. The heat exchanger may be removed and reinstalled, but not replaced without affecting engine calibration.

3-49. REMOVING HEAT EXCHANGER (SII STAGE).

a. Assemble track (refer to section II) around engine from which heat exchanger is to be removed. Install turntable with controls leading, and position hoist at track station 21 for engine positions 1 through 4, or track station 17 for engine position 5.

b. Obtain the following equipment: (Items 4 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer heat exchanger handler 9016790-11

(2) Torque wrench, capable of torquing to 25-35 inch-pounds

(3) Single Head Special Tool Kit G3127

(4) Component handler universal lifting sling 9016779

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Universal joint S8 from engine components installer set 9026251

(7) Extension bar SX-24 from engine components installer set 9026251

(8) Hanger 9024543 from engine components installer set 9026251

(9) Sling 6001-5-4 from Engine Components Installer G4071, shelf 3

(10) Component handling cart 9026253 from engine components installer set 9026251

(11) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting connectors

(3) Cutting tubes

(4) Torquing

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4.) Closures must be certified clean for propellant system use.

e. For engine positions 1 through 4, remove hydraulic pump, using applicable stage procedures.

f. Remove bolts that secure heat exchanger antiflood check valve to heat exchanger. (See figure 3-11.) Remove seal and support heat exchanger antiflood check valve.

g. Disconnect electrical connector P128.

h. Remove bolts and washers that secure oxidizer outlet tube to heat exchanger. Remove seal.

i. Cut oxidizer turbine outlet pressure (TG4) tube.

j. Remove protective cover from heat exchanger bellows.

k. Install handler on heat exchanger with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine; then connect boom to handler, to support heat exchanger.

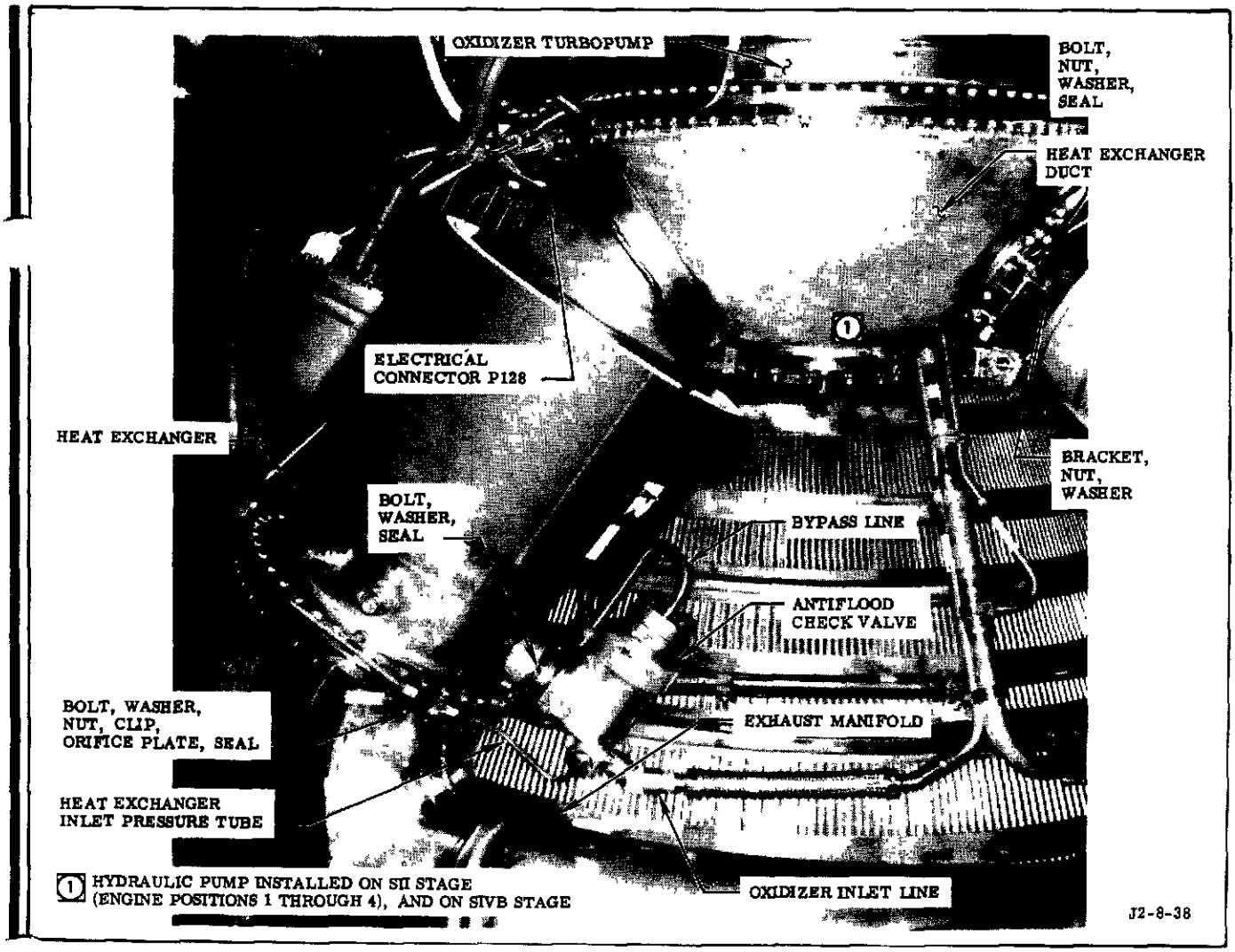


Figure 3-11. Heat Exchanger

l. Remove bolts, washers, clips, and nuts that secure heat exchanger to exhaust manifold.

m. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal and orifice plate. The orifice plate is calibrated and must be retained for reinstallation.

n. Remove bolts and washers that secure bracket to oxidizer pump torque access plate.

o. Remove bolts and washers that secure heat exchanger to oxidizer turbopump, remove seal, and slowly move heat exchanger away from engine.

p. Install adapter on oxidizer turbopump and torque bolts that secure adapter to 25-30 inch-pounds.

q. Install closures on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting component from stage, omit steps s through z; otherwise omit step r.

r. Using hoist, transfer heat exchanger through stage access door and lower into component handling cart.

s. Place hanger in an accessible area near stage access door.

t. Using hoist, move heat exchanger to hanger.

u. Install sling 6001-5-4 on heat exchanger between duct inlet and bellows using a choker hitch.

v. Attach heat exchanger to hanger with sling 6001-5-4. Secure with ball-lock pin.

CAUTION

The heat exchanger must be restrained when removing the hoist to prevent the heat exchanger from striking the hanger or stage work deck.

w. Remove hoist from handler. Manually restrain heat exchanger while removing hoist, to prevent sudden movement of heat exchanger.

x. Install sling 9016779 on handler.

y. Install chain-hoist on hoist, and connect hook to sling 9016779.

z. Slowly raise heat exchanger, remove sling 6001-5-4, and transfer through stage access door. Lower heat exchanger on to component handling cart.

3-50. INSTALLING HEAT EXCHANGER (SII STAGE).

a. Obtain the following equipment: (Items 5 through 10 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer heat exchanger handler 9016790-11

(2) Torque wrench, capable of torquing to 48-105 inch-pounds

(3) Torque wrench adapter T-5044632

(4) Single Head Special Tool Kit G3127

(5) Component handler universal lifting sling 9016779

(6) Chain-hoist 9027095

(7) Universal joint S8 from engine components installer set 9026251

(8) Extension bar SX-24 from engine components installer set 9026251

(9) Hanger 9024543 from engine components installer set 9026251

(10) Sling 6001-5-4 from Engine Components Installer G4071, shelf 3

(11) Component handling cart 9026253 from engine components installer set 9026251

(12) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(13) Automatic Inert Gas Arc Welding Set G3128

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Welding tubes

(3) Connecting electrical connectors

(4) Torquing and safetywiring

c. Install handler on heat exchanger with end supports straddling bellows, handknob down. Aline index marks on handler with instrumentation ports as noted on the handler.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps f through o; otherwise, omit steps d and e.

d. Connect handler to hoist boom and secure with ball-lock pin.

e. Using hoist, raise heat exchanger and ransfer heat exchanger through stage access door.

f. Install sling 9016779 on handler and secure with ball-lock pin.

g. Position hoist on track near stage access door and install chain-hoist on hoist.

h. Move hoist boom through stage access door. Lower and attach chain-hoist hook to lifting ring on sling 9016779.

i. Raise duct and transfer heat exchanger through stage access door to hanger.

j. Install sling 6001-5-4 on heat exchanger between duct inlet and bellows, using a choker hitch.

k. Attach heat exchanger to hanger with sling 6005-5-4. Secure with ball-lock pin.

CAUTION

The heat exchanger must be restrained when removing the hoist to prevent the heat exchanger from striking the hanger or stage work deck.

l. Remove chain-hoist hook from sling 9016779. Remove sling from handler.

m. Remove chain-hoist from hoist.

n. Connect hoist to handler and secure with ball-lock pin.

o. Using hoist, slowly raise heat exchanger. Remove sling 6001-5-4.

p. Position hoist at track station 21 for engine positions 1 through 4, or track station 17 for engine position 5.

q. Remove closures, as required during installation, to initiate connections.

r. Using hoist, move heat exchanger into position on engine.

s. Install seal at turbopump end of heat exchanger and secure duct to turbopump with bolts, nuts, and washers. (See figure 3-11.) Tighten nuts fingertight.

t. Install bracket on oxidizer pump torque access plate and secure with bolts, nuts, and washers. Tighten bolts fingertight.

u. Cross-torque nuts at turbopump flange to 76-84 inch-pounds. Torque the 3 bolts that secure bracket to access plate to 40-50 inch-pounds and safetywire.

v. Install orifice plate and seal at exhaust manifold end of heat exchanger. Loosen handknobs on heat exchanger handler and secure duct to exhaust manifold with bolts, washers, clips, and nuts. Torque nuts to 76-86 inch-pounds.

NOTE

Because of boss interference at the exhaust manifold end of heat exchanger, it may be necessary to install 2 bolts with the heads on the exhaust duct flange instead of on the heat exchanger flange.

w. Weld oxidizer turbine outlet pressure (TG4) tube.

x. Install seal between heat exchanger antiflood check valve and flange on heat exchanger. Secure valve to heat exchanger with bolts and

washers. Using torque wrench adapter, cross-torque bolts to 90-110 inch-pounds.

y. Install oxidizer outlet tube with seal, washers, and bolts. Torque bolts to 48-53 inch-pounds and safetywire.

z. Remove handler from heat exchanger.

aa. Disassemble track. (Refer to section II.)

ab. Connect electrical connector P128.

ac. For engine positions 1 through 4, install hydraulic pump using applicable procedures.

ad. Refer to R-3825-3 for post-maintenance test.

3-51. REMOVING HEAT EXCHANGER (SIVB STAGE).

a. Assemble track for heat exchanger removal, as required for applicable stage. (Refer to section II.) Install turntable with controls trailing.

b. Obtain the following equipment:

(1) Oxidizer heat exchanger handler 9016790-11

(2) Torque wrench capable of torquing to 25-35 inch-pounds

(3) Extension 9027080 from Engine Components Installer G4072, shelf 5

(4) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(5) Single Head Special Tool Kit G3127

(6) Component handler universal lifting sling 9016779

c. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for use in a propellant system.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

(3) Cutting tubes

e. Remove hydraulic pump, using applicable stage procedures.

f. Remove bolts that secure heat exchanger antiflood check valve to heat exchanger. (See figure 3-11.) Remove seal, and support heat exchanger antiflood check valve.

g. Disconnect electrical connector P128.

h. Remove bolts and washers that secure oxidizer outlet tube to heat exchanger. Remove seal.

i. Remove all but 3 bolts from flanges connecting heat exchanger to oxidizer turbopump and exhaust manifold. Remaining bolts securing the flanges should be easily accessible and equally distributed around the flanges.

j. Cut oxidizer turbine outlet pressure (TG4) tube.

k. Remove protective cover from heat exchanger bellows.

l. Install handler on heat exchanger with end supports straddling bellows, handknob down. Aline index marks on handler with instrumentation ports, as noted on the handler.

m. Remove remaining 3 bolts, washers, and nuts that secure heat exchanger to exhaust manifold.

n. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal and orifice plate. The orifice plate is calibrated and must be retained for reinstallation.

o. Install sleeve and extension on hoist. See figure 3-2, view G. Position extension in the ninth (farthest from extension turnbuckle) positioning hole. Secure with ball-lock pin.

p. Attach extension to heat exchanger handler and secure with ball-lock pin.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure turnbuckle operates safely.

q. Manipulate hoist controls and extension turnbuckle to support a portion of heat exchanger weight with hoist. Do not attempt to support full weight of heat exchanger. Manipulate hoist controls and extension turnbuckle to effect a near vertical lift, to minimize side loads. If extension turnbuckle is extended, do not extend it beyond a minimum of one thread, evident in turnbuckle barrel.

r. Incrementally loosen and remove the 3 remaining bolts that secure heat exchanger to oxidizer turbopump. Monitor gap as heat exchanger separates from turbopump to ascertain whether hoist is supporting a sufficient portion of the weight, to prevent a sudden separation, and that a side load does not exist.

s. Remove seal between heat exchanger and turbopump.

NOTE

With the heat exchanger suspended from extension, distance and deflection forces prevent the hoist operator from having adequate visibility and the precise control required to safely manipulate the heat exchanger out of the congested environment. Therefore, until the heat exchanger is clear, a technician will be required to observe and guide the heat exchanger and to assist the hoist operator.

t. Using hoist, move heat exchanger away from engine and to the right, until clear of engine, and both heat exchanger and hoist are to the right of access work platform.

u. Install required closures on opened ports.

v. Install turbopump turbine exhaust duct adapter (closure). Torque bolts to 25-35 inch-pounds.

w. Remove access work platform from installed position, and temporarily store platform in stage.

x. Using hoist, raise heat exchanger through opening provided by removal of access work platform. Move heat exchanger away from opening.

y. Using hoist, move heat exchanger to an accessible area near stage access door.

z. Remove handler (with heat exchanger attached) from hoist and temporarily place on protective pad. Install sling on handler and secure with ball-lock pin.

NOTE

The combined weight of heat exchanger, sling, and handler is approximately 104 pounds.

aa. Using lifting eye on sling, manually carry heat exchanger from stage.

3-52. INSTALLING HEAT EXCHANGER (SIVB STAGE).

a. Obtain the following special tools:

(1) Oxidizer heat exchanger handler 9016790-11

(2) Torque wrench capable of torquing to 48-105 inch-pounds

(3) Torque wrench adapter T-5044632

(4) Extension 9027080 from Engine Components Installer G4072, shelf 5

(5) Sleeve 9027084 (200-series stage) or 9027084-11 (500-series stage) from Engine Components Installer G4072, shelf 3

(6) Single Head Special Tool Kit G3127

(7) Component handler universal lifting sling 9016779

(8) Automatic Inert Gas Arc Welding Set G3128

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

c. Manually carry heat exchanger into stage and place on protective pad. A suggested method of handling the heat exchanger is as follows:

(1) Install handler on heat exchanger with end supports straddling bellows, handknob down.

(2) Aline index marks on handler with instrumentation ports as indicated on handler.

(3) Wrap handler straps around heat exchanger and secure.

(4) Attach sling on handler and secure with ball-lock pin.

NOTE

The combined weight of the heat exchanger, handler, and sling is approximately 104 pounds.

d. Install sleeve and extension on hoist. (See figure 3-2, view G.) Position extension in ninth (farthest from extension turnbuckle) positioning hole. Secure with ball-lock pin.

e. Position heat exchanger upright and attach extension to heat exchanger handler.

f. Remove closures, as required during installation, to initiate connections.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure turnbuckle operates safely.

g. Using hoist, slowly move heat exchanger down, through opening provided by removal of stage work deck, and into position on engine. Adjusting extension turnbuckle will aid in positioning heat exchanger during lowering. Do not extend turnbuckle beyond maximum length (one thread in adjusting barrel evident).

NOTE

With the heat exchanger suspended from the extension, distance and deflection forces prevent the hoist operator from having adequate visibility and the precise control required to safely manipulate the heat exchanger into the congested environment. Therefore, until the heat exchanger is installed, a technician will be required to observe and guide the heat exchanger and to assist the hoist operator.

h. Compress heat exchanger bellows by turning handknobs on handler.

i. Install seal at turbopump end of heat exchanger and secure duct to turbopump with bolts, nuts, and washers. (See figure 3-11.) Tighten nuts fingertight.

j. Cross-torque nuts at turbopump flange to 76-84 inch-pounds.

k. Install orifice plate and seal at exhaust manifold end of heat exchanger. Loosen handknobs on heat exchanger handler and secure duct to exhaust manifold with bolts, washers, clips, and nuts. Torque nuts to 76-84 inch-pounds.

NOTE

Because of boss interference at the exhaust manifold end of the heat exchanger, it may be necessary to install two bolts, with the heads on the exhaust duct flange instead of on the heat exchanger flange.

l. Weld oxidizer turbine outlet pressure (TG4) tube.

m. Install seal between heat exchanger antiflood check valve and flange on heat exchanger. Secure valve to heat exchanger with bolts and washers. Using torque wrench adapter, cross-torque bolts to 95-105 inch-pounds.

n. Install electrical connector P128.

o. Install oxidizer outlet tube with seal, washers, and bolts. Torque bolts to 48-53 inch-pounds and safetywire.

p. Remove handler and hoist from heat exchanger.

q. Disassemble track. (Refer to section II.)

r. Install hydraulic pump, using applicable stage procedures.

s. Refer to R-3825-3 for post-maintenance test.

3-53. INTEGRAL HYDROGEN-HELIUM START TANK.

3-54. The integral hydrogen-helium start tank may be replaced without affecting engine calibration.

3-55. REMOVING INTEGRAL HYDROGEN-HELIUM START TANK (SII STAGE).

a. Assemble track (refer to section II) around engine from which start tank is to be removed. If task is to be performed on engine position 5 (center), install heat shield support turnbuckle. (Refer to section II.) Install turntable with controls leading, and position hoist at track station 23 or 28 for engine positions 1 through 4, or track station 11 for engine position 5.

b. Obtain the following equipment: (Items 6 through 10 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Start tank handler 9026139 from Engine Components Installer G4071, shelf 3 (Handler is required for removing tank position from engine position 5.)

(2) Sling 9022985 (Sling is not required for removing tank from engine position 5 if launch tower umbilical arm is used to transport component from stage.)

(3) Hook 9024600 from Engine Components Installer G4071, shelf 1 (Hook is required for removing tank from engine positions 1 through 4.)

(4) Component handling angle adapter 9027172 from Engine Components Installer G4071, shelf 2 (Adapter is required for removing tank from engine positions 1 through 4.)

(5) Torque wrench adapter T-5038463

(6) Chain-hoist 9027095 from engine components installer set 9026251

(7) Universal joint S8 from engine components installer set 9026251

(8) Extension bar SX-24 from engine components installer set 9026251

(9) Hanger 9024543 from engine components installer set 9026251

(10) Pickup adapter from engine components installer set 9026251

(11) Components handling cart 9026253 from engine components installer set 9026251

(12) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Torquing

d. Install angle adapter and hook on hoist, if start tank is to be removed from engine positions 1 through 4. Install pickup adapter on hook and secure with ball-lock pin. (See figure 3-2, view D.) No adapters are required for engine position 5.

e. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

WARNING

Removing the start tank or start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

f. Prior to removing start tank or start tank components, make sure system is depressurized and has been purged in accordance with purge procedures in R-3825-3, since last time fuel was introduced into system.

g. For engine positions 1 through 4, install sling on start tank and connect to pickup adapter on hoist and secure with ball-lock pin.

WARNING

Removing start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

NOTE

Steps h through l outline start tank vent-and-relief valve (figure 3-12) removal.

h. Prior to removing start tank vent-and-relief valve, make sure system is depressurized and has been purged in accordance with purge procedures in R-3825-3, since last time fuel was introduced into system.

i. Remove bolts, washers, and nuts that secure vent line bracket to support.

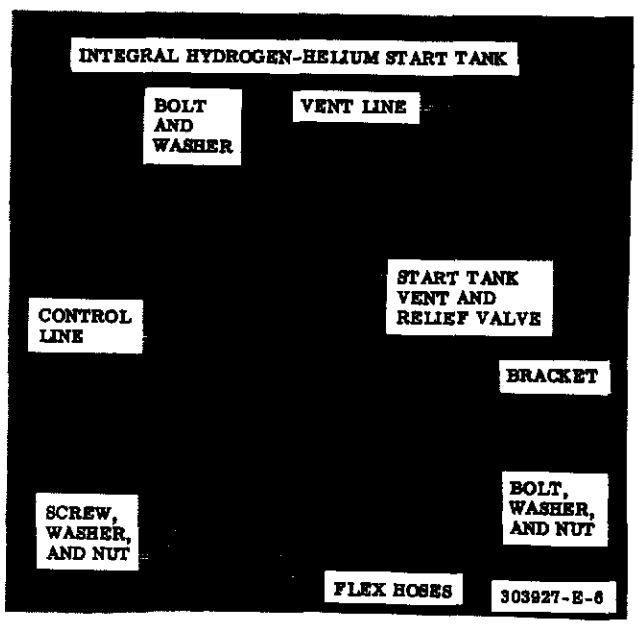


Figure 3-12. Start Tank Vent-and-Relief Valve

j. Remove screw, washer, and nut that secure control line clamp to bracket.

k. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

l. Install closures on all open ports.

m. Temporarily reposition and secure start tank vent-and-relief valve to provide lateral access for removal of integral hydrogen-helium start tank.

n. Disconnect electrical connector P123. (See figure 3-13.)

NOTE

Steps o through t outline start tank discharge valve removal.

o. Disconnect electrical connector P118. (See figure 3-14.)

p. Remove control valve and adapter (figure 3-15) as follows:

(1) Remove bolts and washers that secure start tank discharge valve control line and control valve to adapter. Remove seals.

(2) Disconnect clamp on adapter tube; remove bolts, washers (both ends), and bracket that secure adapter to start tank discharge valve; and remove seals and adapter.

(3) Install closures on all open ports.

CAUTION

Flanges must be separated carefully or sealing surfaces can be damaged.

q. Remove bolts that secure start tank discharge valve hose to start tank discharge valve, carefully separate flanges, and remove seal. (See figure 3-14.)

r. Secure start tank discharge valve hose, to prevent interference with removal of valve.

s. Remove bolts and washers that secure bleed line to start tank discharge valve. Remove seal.

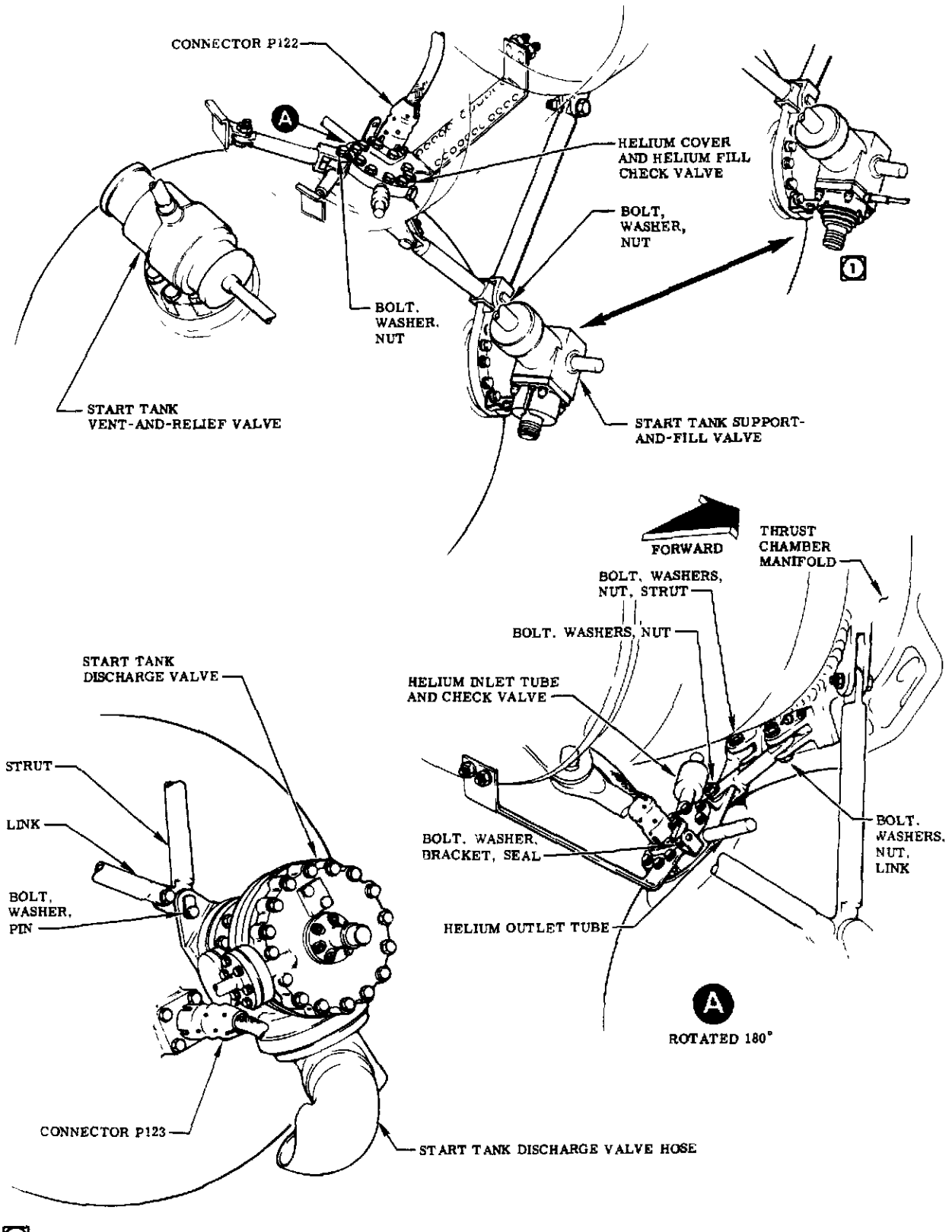


Figure 3-13. Integral Hydrogen-Helium Start Tank

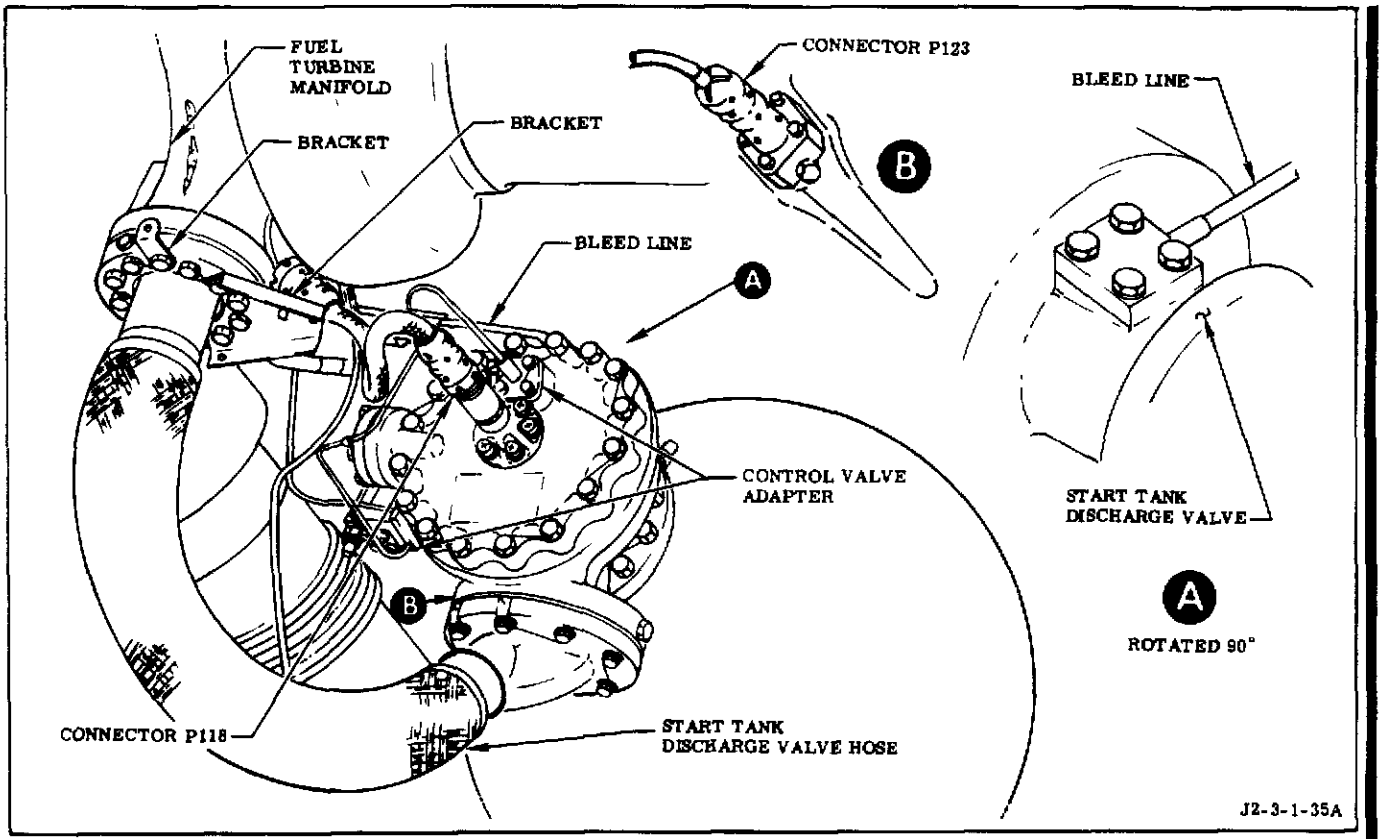


Figure 3-14. Start Tank Discharge Valve Hose

t. Using torque wrench adapter, remove bolts that secure discharge valve to start tank. Carefully remove discharge valve and seal.

u. If start tank is being removed from engine position 5, connect handler to start tank discharge valve port on start tank, with twist socket on bottom of start tank, and torque captive bolts to 25 ±5 inch-pounds. Otherwise, install closures on all open ports.

v. For engine position 5, connect boom to handler and secure with ball-lock pin.

NOTE

Steps w through z outline start tank support-and-fill valve (figure 3-16) removal.

w. Remove bolts, washers, and nuts that secure fill line to support.

x. Support start tank and remove bolt from tank support strut.

y. Cut safetywire and remove bolts that attach valve to tank.

CAUTION

Flanges must be separated carefully or sealing surfaces can be damaged.

z. Using care not to damage sealing surfaces, move start tank support-and-fill valve from tank. It may be necessary to remove attaching hardware from the pressure indicating, initial fill, and fill lines to obtain adequate clearance when moving the valve. Secure start tank support-and-fill valve, to provide lateral access for removal of start tank.

aa. Remove electrical harness support clamps, as required, to gain access to helium cover attaching bolts.

ab. Remove bolt, washers, and pin that secure strut and link to mounting bracket located at start tank discharge valve.

ac. Remove bolts and washers that secure helium cover to start tank.

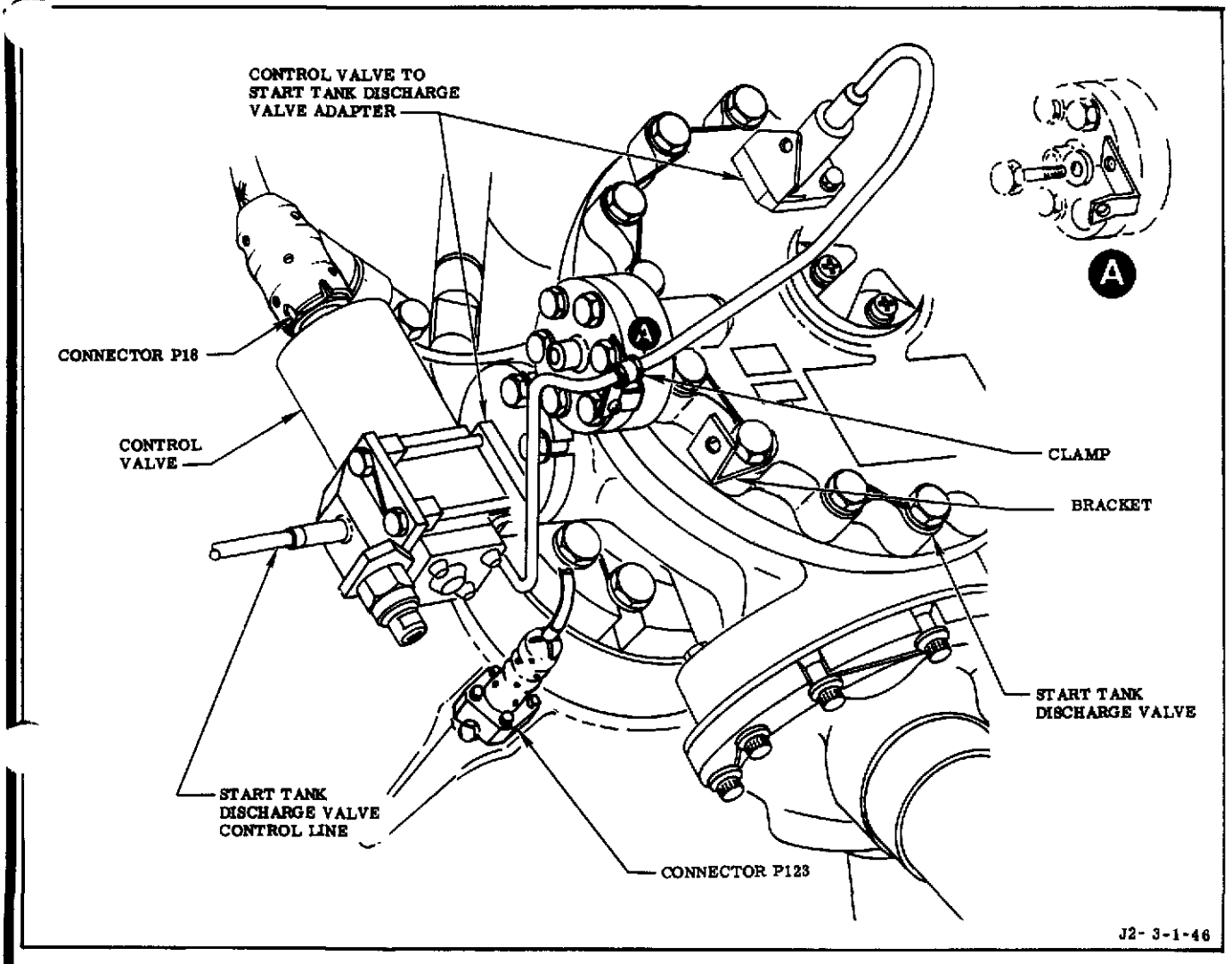


Figure 3-15. Start Tank Discharge Valve Control Valve

CAUTION

Flanges must be separated carefully to avoid damage to sealing surfaces.

ad. Slowly move start tank directly away from helium cover, using care not to damage sealing surfaces and tube extending from helium cover into start tank. Tube extends into start tank 3 inches.

ae. Install closures on all open ports.

af. Make sure start tank is free of engine; then move it clear of engine.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps ah through ap; otherwise omit step ag.

ag. Using hoist, transfer start tank through stage access door and lower on to component handling cart. Remove handler if installed and install closure. Remove sling if installed.

ah. Place hanger in an accessible area near stage access door.

ai. Using hoist, transfer start tank near hanger.

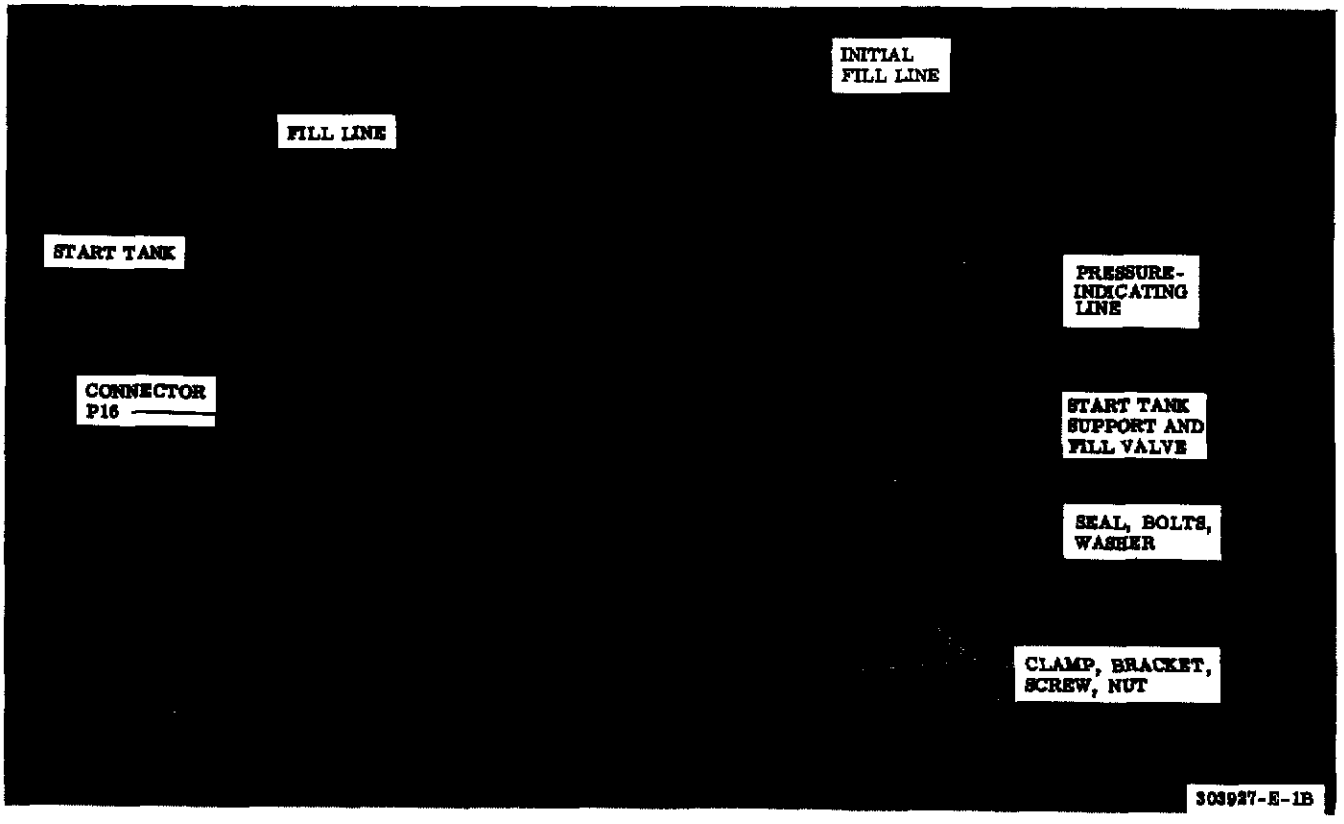


Figure 3-16. Start Tank Support-and-Fill Valve

aj. If handler 9026189 is installed on start tank, install sling 9022985 on start tank. Position sling so that start tank can be suspended from hanger. Attach pickup adapter to hanger and secure with ball-lock pin.

ak. Adjust hoist so that pickup adapter engages hanger clevis. If handler is installed connect sling lifting ring to pickup adapter. Secure with ball-lock pin.

al. Remove hoist from pickup adapter. If handler is installed, remove hoist from handler.

am. Remove hook and angle adapter from hoist (if installed), and install chain-hoist.

an. Attach chain-hoist hook to sling lifting ring. Using hoist, raise start tank and disconnect start tank sling from pickup adapter.

ao. If handler is installed, remove handler and install closure.

ap. Using hoist, move start tank through stage access door and lower to component handling cart.

3-56. INSTALLING INTEGRAL HYDROGEN-HELIUM START TANK (SII STAGE).

a. Obtain the following equipment: (Items 8 through 12 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Start tank handler 9026189 from Engine Components Installer G4071, shelf 3 (Handler is required only for installing tank on engine position 5.)

(2) Start tank sling 9022985 (Sling is not required for installing tank on engine position 5 if launch tower umbilical arm is used to transport component from stage.)

(3) Torque wrench capable of torquing to 6-126 inch-pounds

(4) Torque wrench capable of torquing to 147-346 inch-pounds

(5) Adapter 9027172 from Engine Components Installer G4071, shelf 2 (Adapter is

required only for installing tank on engine positions 1 through 4.)

(6) Torque wrench adapter T-5038463

(7) Hook 9024600 from Engine Components Installer G4071, shelf 3 (Hook is required only for installing tank on engine positions 1 through 4.)

(8) Chain-hoist 9027095 from engine components installer set 9026251

(9) Universal joint S8 from engine components installer set 9026251

(10) Extension bar SX-24 from engine components installer set 9026251

(11) Hanger 9024543 from engine components installer set 9026251

(12) Pickup adapter 9024547 from engine components installer set 9026251

(13) Cart 9026253 from engine components installer set 9026251

(14) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Connecting electrical connectors

(3) Torquing

(4) Safetywiring

c. Install sling 9022985 on start tank for engine positions 1 through 4. Orient start tank as installed on engine in sling.

d. Install handler 9026189 on start tank for engine position 5, position handler on discharge valve flange of start tank and aline handler with strut bolthole on flange with the hoist socket on bottom side of start tank. Install bolts and torque to 20-30 inch-pounds.

NOTE

If the launch tower umbilical is to be used for transporting the component into the stage, omit steps h through p; otherwise omit steps e through g.

e. If start tank is to be installed on engine positions 1 through 4, install angle adapter and hook on boom. (See figure 3-2, view E.) Adapters are not required for engine position 5.

f. Connect hoist to handler or sling and secure with ball-lock pin.

g. Using hoist, move start tank through stage access door.

h. Install chain-hoist on hoist.

i. If handler is installed on start tank, install sling 9022985 on start tank.

j. Lower chain-hoist hook and attach to sling lifting ring.

k. Using hoist, raise start tank and move it through stage access door to hanger.

l. Using hoist, position start tank so that sling lifting ring engages pickup adapter on hanger. Secure with ball-lock pin.

m. Remove chain-hoist-hook from sling. Remove chain-hoist from hoist.

n. If start tank is to be installed on engine positions 1 through 4, install angle adapter and hook on boom. (See figure 3-2, view E.) Adapters are not required for engine position 5.

o. Connect hoist to handler or pickup adapter. Secure with ball-lock pin.

p. Raise start tank and remove ball-lock pin. Remove sling if start tank is attached to handler.

q. Position hoist at track station 23 or 28 for engine positions 1 through 4, or track station 11 for engine position 5.

r. Remove closures, as required, during installation, to make connections.

s. Place seal on helium cover.

CAUTION

Flanges must be mated carefully to avoid damage to seal and/or sealing surfaces.

t. Using hoist, slowly move start tank on to helium cover on engine.

u. Secure start tank to helium cover with bolts and washers. Position electrical support bracket under bolts and washers. Torque bolts to 147-163 inch-pounds and safetywire.

v. Attach strut and link to mounting bracket, located at start tank discharge valve flange. with pin, washer, and bolt. Torque bolt to 48-52 inch-pounds.

w. Remove handler or sling from start tank.

x. Install electrical harness support clamps that were removed to gain access to helium cover attaching bolts.

y. If task is being performed on engine position 5 (center), remove heat shield support turnbuckle and reinstall heat shield V-strut, using applicable stage procedures.

NOTE

Steps z through ab outline start tank support-and-fill valve installation.

z. Position valve and seal on tank flange, and secure with bolts and washers. Torque bolts to 253-279 inch-pounds and safetywire. (See figure 3-16.)

aa. Connect 2 struts to valve with bolt, nut, and washer. Torque nut to 85-110 inch-pounds.

ab. Install bolts, washers (under bolt head), and nuts securing fill line to support. Torque bolts to 55-75 inch-pounds.

NOTE

Steps ac through al outline start tank discharge valve installation.

ac. Carefully position discharge valve and seal on start tank and secure with bolts and washers. Using torque wrench adapter torque bolts to 228-252 inch-pounds and safetywire.

ad. Install seal and connect bleed line to start tank discharge valve with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

ae. Install seal and start tank discharge valve hose on discharge valve and secure with bolts and washers. Torque bolts to 314-346 inch-pounds and safetywire.

af. Connect electrical connector P118.

ag. Install start tank discharge valve control valve and adapter (see figure 3-15) as follows:

(1) Install seals between adapter and start tank discharge valve. Install bracket, and bolts and washers at both ends of adapter tube. Torque bolts to 41-45 inch-pounds and safetywire.

(2) Install clamp on adapter tube and torque screw to 27-33 inch-pounds.

(3) Position seals and control valve on adapter. Install start tank discharge valve control line and secure with bolts and washers. Torque bolts to 29-31 inch-pounds and safetywire.

NOTE

Steps ah through aj outline start tank vent-and-relief valve installations.

ah. Position valve and seal (see figure 3-12) on tank flange and secure with bolts and washers. Torque bolts to 114-126 inch-pounds and safetywire.

ai. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 inch-pounds.

aj. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 inch-pounds.

ak. Connect electrical connector P123. (See figure 3-13.)

al. Disassemble track. (Refer to section II.)

am. Refer to R-3825-3 for post-maintenance test.

3-57. REMOVING INTEGRAL HYDROGEN-HELIUM START TANK (SIVB STAGE).

a. Assemble track. Refer to section II for start tank removal, as required for applicable stage. Install turntable on track with controls leading.

b. Obtain the following equipment:

(1) Single Head Special Tool Kit G3127

(2) Start tank sling 9022985

(3) Hook 9024600 from Engine Components Installer G4072, shelf 3

(4) Torque wrench adapter T-5038463

c. Install hook on hoist and secure with ball-lock pin. (See figure 3-2, view A.)

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Disconnecting electrical connectors

(2) Installing closures secured with threaded fasteners.

e. Obtain closures, or suitable equivalents. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

WARNING

Removing the start tank or start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

f. Prior to removing start tank or start tank components, make sure system is depressurized and has been purged in accordance with purge procedures in R-3825-3, since last time fuel was introduced into system.

NOTE

Steps g through k outline start tank vent-and-relief valve (figure 3-12) removal.

g. Remove bolts, washers, and nuts that secure vent line bracket to support.

h. Remove screw, washer, and nut that secure control line clamp to bracket.

i. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

j. Install closures on all open ports.

k. Temporarily reposition and secure start tank vent-and-relief valve to provide lateral access for removal of start tank.

l. Disconnect electrical connector P123. (See figure 3-13.)

NOTE

Steps m through s outline start tank discharge valve removal.

m. Disconnect electrical connector P118. (See figure 3-14.)

n. Remove control valve and adapter as follows:

(1) Remove clamp that secures control valve adapter tube to bracket on start tank discharge valve.

(2) Remove bolts and washers that secure both ends of control valve adapter to start tank discharge valve, and remove bracket and seals.

(3) Install closure on all open ports.

(4) Support control valve and adapter to prevent damage.

CAUTION

Flanges must be separated carefully to prevent damage to sealing surfaces.

o. Remove bolts and washers that secure start tank discharge valve hose to start tank discharge valve, carefully separate flanges, and remove seal. (See figure 3-14.) Install closures on open ports.

p. Secure start tank discharge valve hose, to prevent interference with removal of valve.

q. Remove bolts and washers that secure bleed line to start tank discharge valve. Remove seal, and install closures on open ports.

r. Using torque wrench adapter, remove bolts and washers that secure discharge valve to start tank. Carefully remove valve and seal.

s. Install closures on open ports.

NOTE

If the start tank discharge valve is to be replaced, the three 1/8-inch bleed plugs, and bolts, washers, bracket, and cap from the discharge valve control port. must be removed and retained for installation on the replacement valve.

t. Install sling on start tank and connect sling to hook on hoist. Secure hook latch with ball-lock pin.

NOTE

Steps u through y outline start tank support-and-fill valve removal.

u. Remove bolts, washers, and nuts that secure fill line to support.

v. Support start tank and remove bolts from tank support strut.

w. Cut safetywire and remove bolts that attach valve to tank.

CAUTION

Flanges must be separated carefully to prevent damage to sealing surfaces.

x. Using care not to damage sealing surfaces, move start tank support-and-fill valve from tank. It may be necessary to remove attaching hardware from the pressure-indicating, initial fill, and fill lines to obtain adequate clearance when moving the valve. Secure start tank support-and-fill valve, to provide lateral access for removal of start tank.

y. Install closures on all open ports.

z. Remove electrical harness support clamps, as required, to gain access to helium cover attach bolts.

aa. Loosen bolts that secure electrical support bracket to helium cover.

ab. Remove bolt, washer, and pin that secure strut and link to mounting bracket located at start tank discharge valve.

ac. Remove bolts and washers that secure helium cover to start tank.

CAUTION

Flanges must be separated carefully to prevent damage to sealing surfaces.

- The tank must be moved directly away from the helium cover to prevent damage to the tube extending from the helium cover.

ad. Slowly move start tank directly away from helium cover, using care not to damage sealing surfaces and tube extending from helium cover into start tank. Tube extends into start tank 3 inches.

ae. Install closures on all open ports.

af. Make sure start tank is clear of engine. then, using hoist. move start tank to an accessible area near stage access door.

ag. Using sling, remove start tank from hoist and manually carry start tank from stage.

NOTE

The weight of the start tank is 89 pounds.

3-58. INSTALLING INTEGRAL HYDROGEN-HELIUM START TANK (SIVB STAGE).

a. Obtain the following equipment:

(1) Start tank sling 9022985

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Torque wrench capable of torquing to 6-126 inch-pounds

(4) Torque wrench capable of torquing to 147-346 inch-pounds

(5) Automatic Inert Gas Arc Welding Set G3128

(6) Single Head Special Tool Kit G3127

(7) Torque wrench adapter T-5038463

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Torquing

(3) Safetywiring

c. Install hook on hoist, and locate hoist in an accessible area near stage access.

NOTE

The weight of the start tank is 89 pounds.

d. Install sling on start tank, and manually carry start tank into stage. Install sling on hoist, and secure hook latch with ball-lock pin. Step e may be accomplished prior to bringing the start tank into the stage.

e. Inspect and clean start tank as follows:

(1) Remove closure from start tank opening and visually inspect interior to tank for any foreign particles. Insert only oxidizer-clean equipment into tank.

(2) Do not nick or scratch start tank sealing flange or any surface inside of start tank.

(3) If foreign particles are found inside start tank, proceed to substep 4. If no foreign particles are found inside start tank, proceed to step f.

(4) Obtain a vacuum cleaner with an oxidizer-clean extension long enough to reach bottom of start tank.

(5) Install a piece of oxidizer-clean Tygon tubing on vacuum cleaner extension to prevent nicking or scratching any surface inside of start tank.

(6) Secure Tygon tubing to vacuum cleaner extension to prevent it from coming off of extension inside of start tank.

(7) Remove all foreign particles from inside of start tank.

f. Orient start tank in sling as installed on engine.

g. Using hoist, move start tank to engine position.

h. Remove closures, as required during installation, to make connections.

i. Place seal on helium cover.

CAUTION

Flanges must be mated carefully to prevent damage to seal and/or sealing surfaces.

j. Using hoist, guide start tank on to helium cover, using care not to damage seal or sealing surfaces.

k. Secure start tank to helium cover with bolts and washers. Position electrical support bracket under bolts and washers. Torque bolts to 147-163 inch-pounds and safetywire.

l. Attach strut and link to mounting bracket, located at start tank discharge valve flange, with pin, washer, and bolt. Torque bolt to 48-52 inch-pounds.

m. Install electrical harness support clamps removed to gain access to helium cover.

n. Remove sling from start tank.

o. Disassemble track. (Refer to section II.)

NOTE

Steps p through r outline start tank support-and-fill valve installation.

p. Position start tank support-and-fill valve and seal on tank flange and secure with bolts and washers. Torque bolts to 253-279 inch-pounds and safetywire. (See figure 3-16.)

q. Connect 2 struts to valve with bolt, nut, and washer. Torque nut to 85-110 inch-pounds.

r. Install bolts, washers (under bolt head), and nuts securing fill line to support. Torque bolts to 55-75 inch-pounds.

s. Install attaching hardware removed from pressure-indicating, initial fill, and fill lines to gain clearance during removal of start tank support-and-fill valve.

NOTE

Steps t through ae outline start tank discharge valve installation. The start tank discharge valve may be reinstalled or replaced.

t. If start tank discharge valve is to be reinstalled, proceed to step u. If start tank discharge valve is to be replaced, proceed to substep 1:

(1) Install three 1/8-inch bleed plugs (retained from previously removed valve) on replacement valve. Tighten bleed plugs finger-tight.

NOTE

Bleed plugs will be removed during leak test; following leak test, bleed plugs will be reinstalled, torqued to 22-28 inch-pounds, and safetywired.

(2) Install seal, cap, and bracket (cap and bracket retained from previously removed valve) on valve control port and secure with bolts and washers. Torque bolts to 41-45 inch-pounds and safetywire.

u. Remove closure from start tank discharge valve, and visually inspect threads in parent metal and/or thread inserts (in discharge valve and start tank) for damage and correct installation. (Refer to R-3825-3.)

v. Make sure start tank discharge valve and start tank is clean and OK to install valve.

w. Position seal and start tank discharge valve on start tank and secure with bolts and washers. Using torque wrench adapter, cross-torque bolts to 228-252 inch-pounds and safetywire.

x. Install seal and secure bleed line to discharge valve with bolts and washers. Cross-torque bolts to 41-45 inch-pounds and safetywire.

y. Position seal and install 2 bolts and washers in flange on start tank discharge valve where slots in flange of start tank discharge valve hose will mate. Do not tighten bolts.

z. Position start tank discharge valve hose on start tank discharge valve and install remaining bolts and washers. Cross-torque bolts to 314-316 inch-pounds and safetywire.

aa. Position seal and control valve adapter (see figure 3-15) on start tank discharge valve and secure with bolts and washers. Cross-torque bolts to 41-45 inch-pounds and safetywire.

ab. Position seal, control valve adapter, and bracket on start tank discharge valve control port and secure with bolts and washers. Cross-torque bolts to 41-45 inch-pounds and safetywire.

ac. Install clamp on control valve adapter tube and secure clamp to bracket with screw, nut, and washer. Torque screw to 24-30 inch-pounds.

ad. Connect temperature connector P123.

ae. Connect electrical connector P118.

NOTE

Steps af, ag, and ah outline start tank vent-and-relief valve installation.

af. Position valve and seal (see figure 3-12) on tank flange and secure with bolts and washers. Torque bolts to 114-126 inch-pounds and safetywire.

ag. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 inch-pounds.

ah. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 inch-pounds.

ai. Refer to R-3825-3 for post-maintenance test procedures.

3-59. OXIDIZER INLET DUCT.

3-60. The oxidizer inlet duct may be replaced from engine positions 1 through 4 without affecting engine calibration. Remove oxidizer inlet duct from engine position 5, using applicable stage procedures.

3-61. REMOVING OXIDIZER INLET DUCT (SII STAGE).

a. Assemble track (refer to section II) around engine position (1 through 4) from which inlet duct is to be removed. Install turntable with controls following, and position hoist at track station 20 for engine positions 1 through 4.

b. Obtain the following equipment: (Items 3 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Angle adapter 9027172 from Engine Components Installer G4071, shelf 2

(2) Oxidizer inlet duct handler 9016785-11

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Components handling cart 9026253 from engine components installer set 9026251

(7) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(8) Adapter T-5040045

c. Install angle adapter on hoist, in position shown in figure 3-2, view E.

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

e. Carefully remove insulation from oxidizer inlet duct. (Refer to R-3825-3.)

NOTE

Insulation can be reinstalled if not damaged during removal. Cutting insulation within 1/2-inch of the bond joint, but not on the bond joint, will prevent damage.

f. Remove all but 2 diametrically opposite bolts that secure oxidizer inlet duct to customer-connect flange. (See figure 3-17.)

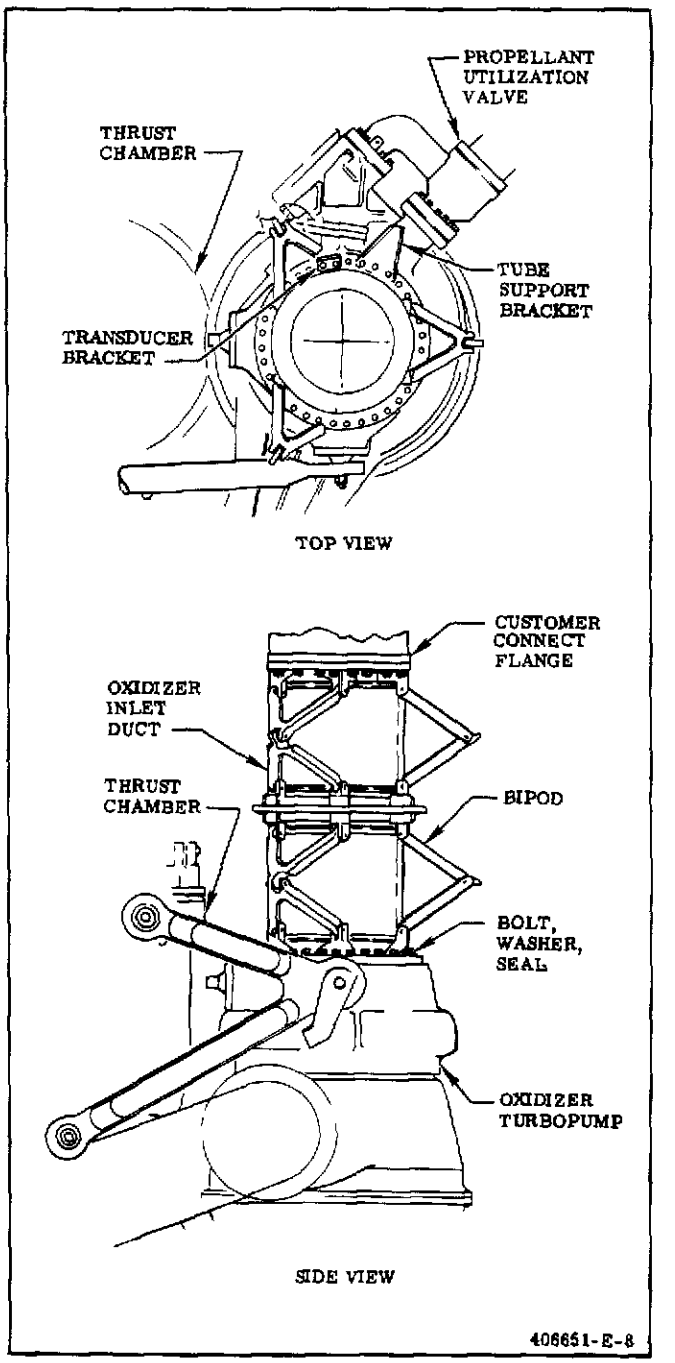


Figure 3-17. Oxidizer Inlet Duct

g. Using torque wrench adapter, remove bolts that secure oxidizer inlet duct to oxidizer turbopump inlet flange.

h. Install handler on oxidizer inlet duct with adapter positioned toward track station 20.

i. Remove remaining bolts that secure oxidizer inlet duct to customer-connect flange.

j. Compress duct to maximum allowed by handler.

k. Carefully remove seal from between oxidizer inlet duct and customer-connect flange.

l. Using hoist, raise inlet duct high enough for alinement pin to clear turbopump flange and also to clear seal; then carefully move oxidizer inlet duct clear of engine. Remove seal.

m. Install closures on oxidizer inlet duct and all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps o through r; otherwise, omit step n.

n. Using hoist, transfer duct through stage access door and lower into component handling cart.

o. Using hoist, transfer duct by stage access door and stow on protective pad.

p. Remove angle adapter from hoist and install chain-hoist.

q. Attach hoist hook to lifting ring on handler and raise duct.

r. Using hoist, transfer duct through stage access door and lower into component handling cart.

3-62. INSTALLING OXIDIZER INLET DUCT (SII STAGE).

a. Obtain the following equipment: (Items 5 through 7 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Oxidizer inlet duct handler 9016785-11

(2) Angle adapter 9027172 from Engine Components Installer G4071, shelf 2

(3) Torque wrench capable of torquing to 105-115 inch-pounds

(4) Torque wrench adapter T-5040045

(5) Chain-hoist 9027095 from engine components installer set 9026251

(6) Universal joint S8 from engine components installer set 9026251

(7) Extension bar SX-24 from engine components installer set 9026251

(8) Components handling cart 9026253 from engine components installer set 9026251

(9) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

b. Check oxidizer inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-3.

c. Install handler on oxidizer inlet duct, positioned so that bleed plugs on inlet duct are alined with, and adjacent to, handler adapter. Using handler, compress inlet duct to maximum allowed by handler.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps d through g.

d. Install chain-hoist to hoist boom and extend hoist boom through stage access door.

e. Lower hoist hook and attach to lifting ring of handler.

f. Using hoist, raise duct and transfer duct in through stage access door and place duct on protective pad.

g. Remove hoist from hoist boom.

h. Install angle adapter on boom. (See figre 3-2, view E.)

i. Connect handler to hoist, and position hoist at track station 20 for engine positions 1 through 4.

j. Remove closures, as required during installation, to make connections.

k. Before installing inlet duct, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

l. Carefully place seal on oxidizer turbopump inlet flange. (See figure 3-17.)

m. Using hoist, move oxidizer inlet duct into position on engine and aline oxidizer inlet duct flange pin with hole in oxidizer turbopump inlet flange. Take care not to allow oxidizer inlet duct to bump or otherwise damage seal.

n. Using hoist, lower oxidizer inlet duct into oxidizer turbopump inlet flange.

o. Carefully place seal between oxidizer inlet duct and customer flange and, using handler, release compression on oxidizer inlet duct bellows.

p. Remove handler from oxidizer inlet duct.

q. Disassemble track. (Refer to section II.)

r. Secure oxidizer inlet duct to customer-connect flange, using applicable stage procedures.

s. Install transducer support bracket and secure with 2 dry-film lubricated bolts and washers. Do not torque bolts at this time.

t. Install tube support bracket and secure with 3 dry-film lubricated bolts and washers. Do not torque bolts at this time.

u. Install remaining dry-film lubricated bolts and washers to secure oxidizer inlet duct to turbopump inlet flange. Using torque wrench adapter, cross-torque all bolts to 105-115 inch-pounds and safetywire.

v. Install insulation on oxidizer inlet duct. (Refer to R-3825-3 for installation procedures.)

3-63. REMOVING OXIDIZER INLET DUCT (SIVB STAGE).

a. Assemble track for oxidizer inlet duct removal, as required for applicable stage. (Refer to section II.) Install turntable with controls leading.

b. Obtain the following equipment:

(1) Oxidizer inlet duct handler 9016785-11

(2) Adapter T-5040045

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Removal of insulation

d. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

e. Carefully remove insulation from oxidizer inlet duct.

NOTE

Insulation can be reinstalled if not damaged during removal. Cutting insulation within 1 2-inch of bond joint, but not on bond joint, will prevent damage.

f. Remove all but 2 diametrically opposite bolts that secure oxidizer inlet duct to customer-connect flange.

g. Using torque wrench adapter, remove bolts that secure oxidizer inlet duct to oxidizer turbopump inlet flange.

h. Install handler on hoist, and position hoist approximately over propellant utilization valve.

i. Install handler on oxidizer inlet duct, jockeying handler into position by using hoist.

j. Remove remaining bolts that secure duct to customer-connect flange.

k. Compress duct to maximum allowed by handler.

l. Carefully remove seal from between oxidizer inlet duct and customer-connect flange.

m. Using hoist, raise oxidizer inlet duct high enough for alinement pin to clear turbopump flange seal; then carefully move oxidizer inlet duct clear of engine. Remove seal.

NOTE

The oxidizer inlet duct should move outward and upward on a radial line from the engine axis.

n. Install closures on oxidizer inlet duct and all open ports.

o. Using hoist, move oxidizer inlet duct to an accessible area near stage access door.

p. Remove handler (with oxidizer inlet duct installed) from hoist. If oxidizer inlet duct is being removed to remove oxidizer turbopump, place oxidizer inlet duct and handler on a protective pad.

NOTE

The combined weight of the oxidizer inlet duct and handler is approximately 117 pounds.

q. Using lifting eye on handler, manually carry oxidizer inlet duct from stage.

3-64. INSTALLING OXIDIZER INLET DUCT (SIVB STAGE).

a. Obtain the following equipment:

(1) Oxidizer inlet duct handler 9016785-11

(2) Torque wrench capable of torquing to 105-115 inch-pounds

(3) Torque wrench adapter T-5040045

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Torquing

(2) Safetywiring

(3) Insulation installation

c. Manually carry oxidizer inlet duct into stage. A suggested method of handling duct is to install handler on duct. Position handler so that bleed plugs on duct are adjacent to handler adapter socket.

NOTE

Steps d and e may be accomplished prior to moving the oxidizer inlet duct into the stage.

d. Check alinement of oxidizer inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of marks does not exceed 0.066 inch. If duct alinement is not satisfactory, aline duct in accordance with procedures in R-3825-3.

e. Prior to installing oxidizer inlet duct, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

f. Install handler on hoist and secure with ball-lock pin. If duct is not installed in handler, install duct so that bleed plugs are adjacent to handler adapter socket.

g. Using handler, compress oxidizer inlet duct to maximum allowed by handler.

h. Using hoist, move oxidizer inlet duct to engine and orient duct for installation.

i. During installation, remove closures, as required, to make connections.

j. Carefully place seal on oxidizer turbopump inlet flange.

CAUTION

Bumping or striking the seal can damage the seal.

k. Using hoist, aline oxidizer inlet duct pin with hole in oxidizer turbopump inlet flange; then lower oxidizer inlet duct into oxidizer turbopump inlet flange. Take care not to allow oxidizer inlet duct to bump or strike seal.

l. Carefully place seal between oxidizer inlet duct and customer flange, and, using handler, release compression on oxidizer inlet duct bellows.

m. Remove handler from oxidizer inlet duct. Perform task carefully as duct is not secured and is held in by compression only.

n. Disassemble track. (Refer to section II.)

o. Secure oxidizer inlet duct to customer-connect flange, using applicable stage procedures.

p. Install transducer support bracket and secure with 2 dry-film lubricated bolts and washers. Do not torque bolts at this time.

q. Install tube support bracket and secure with 3 dry-film lubricated bolts and washers. Do not torque bolts at this time.

r. Install remaining dry-film lubricated bolts and washers to secure oxidizer inlet duct to turbopump inlet flange. Using torque wrench adapter, cross-torque all bolts to 105-115 inch-pounds and safetywire.

s. Check oxidizer inlet duct null-point index marks scribed in 3 places on circumference of duct. Duct alinement is satisfactory if total misalinement of all 3 sets of index marks does not exceed 0.066 inch. If duct misalinement exceeds 0.066 inch, aline duct in accordance with procedures in R-3825-3.

t. Refer to R-3825-3 for post-maintenance tests.

u. Install insulation on oxidizer inlet duct. (Refer to R-3825-3.)

3-65. OXIDIZER HIGH-PRESSURE DUCT.

3-66. The oxidizer high-pressure duct may be replaced without affecting engine calibration.

3-67. REMOVING OXIDIZER HIGH-PRESSURE DUCT (SII STAGE).

a. Install track (refer to section II) around engine position from which duct is to be removed. Install turntable with controls leading, and position hoist at track station 12 for engine positions 1 through 4, or track station 20 for engine position 5.

b. Obtain the following equipment: (Items 2 through 5 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer feed system handler 9016786

(2) Sling 9016779

(3) Chain-hoist 9027095 from engine components installer set 9026251

(4) Universal joint S8 from engine components installer set 9026251

(5) Extension bar SX-24 from engine components installer set 9026251

(6) Component handling cart 9026253 from engine components installer set 9026251

(7) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(8) Single Head Special Tool Kit G3127

c. Obtain closures, or suitable equivalent. (Refer to R-3825-3.) Closures must be certified clean for propellant system use.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

e. Remove bolts and washers that secure oxidizer bleed valve to oxidizer high-pressure duct. Remove seal. (See figure 3-18.)

f. Disconnect electrical connectors P111 and P125.

g. Using tube cutter from Single Head Special Tool Kit G3127, cut oxidizer turbopump discharge pressure tube.

h. On engines not incorporating MD105 change, remove bolts and washers that secure heat exchanger inlet tube to oxidizer high-pressure duct. Remove seal.

i. Install closures on all open ports.

j. Install handler on oxidizer high-pressure duct with straps attached to black hooks, elbow upward, and hoist socket approximately horizontal and pointing toward center of engine.

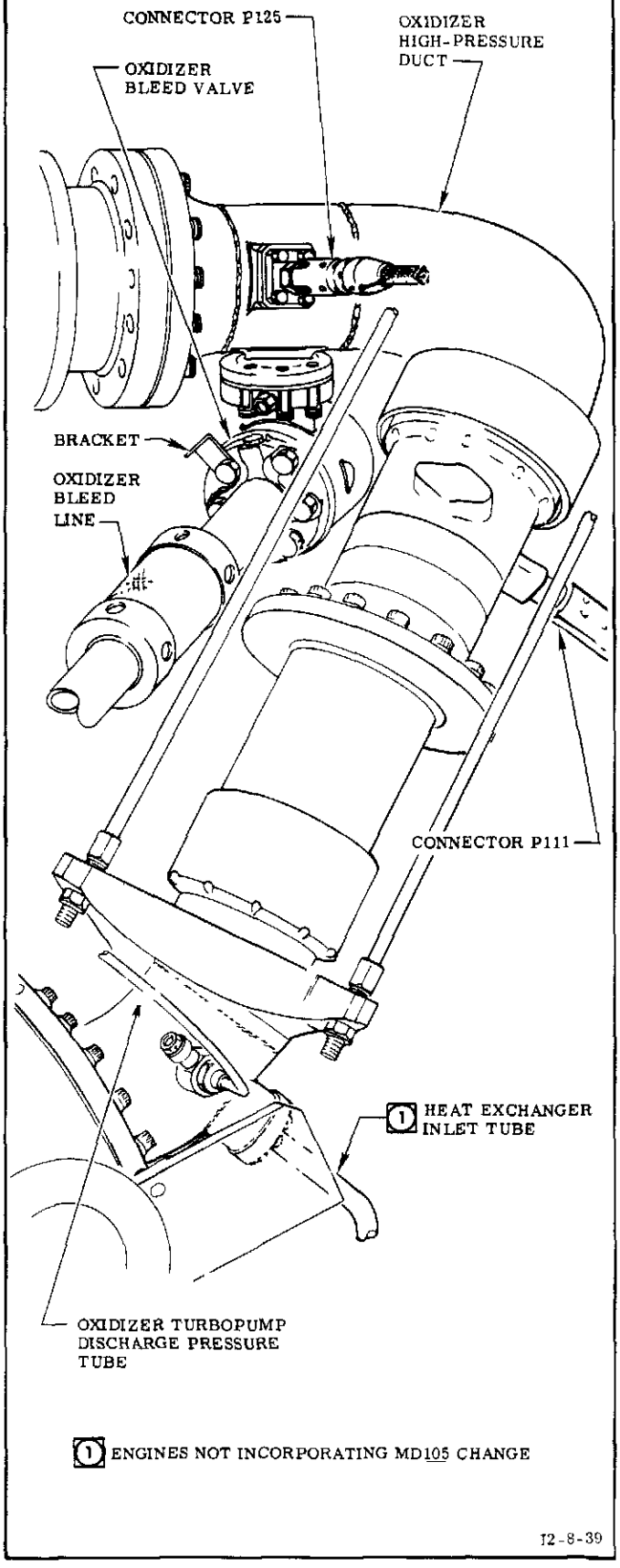


Figure 3-18. Oxidizer High-Pressure Duct

k. Connect hoist to handler to support oxidizer high-pressure duct and secure with ball-lock pin.

l. Remove bolts, washers, and bracket that secure oxidizer high-pressure duct to oxidizer turbopump.

m. On engines incorporating MD180 or MD181 change, disconnect electrical connectors P20 and P26. Remove mainstage OK pressure switch and adapter plate.

n. Remove remaining bolts and washers that secure oxidizer high-pressure duct to main oxidizer valve. (See figure 3-19.)

o. Make sure oxidizer high-pressure duct is free from engine; then move duct clear of engine. Remove seals.

p. If oxidizer inlet orifice plate is to be removed, remove snapring and lift out orifice plate.

q. Install closures on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps s through v; otherwise, omit step r.

r. Using hoist, transfer duct through stage access door and lower into component handling cart.

s. Using hoist, transfer duct by stage access door and stow on protective pad.

t. Attach sling to duct handler.

u. Install chain-hoist on boom and attach hoist hook to sling.

v. Using hoist, raise duct and transfer through stage access door and lower into component handling cart.

3-68. INSTALLING OXIDIZER HIGH-PRESSURE DUCT (SII STAGE).

a. Obtain the following equipment: (Items 6 through 9 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

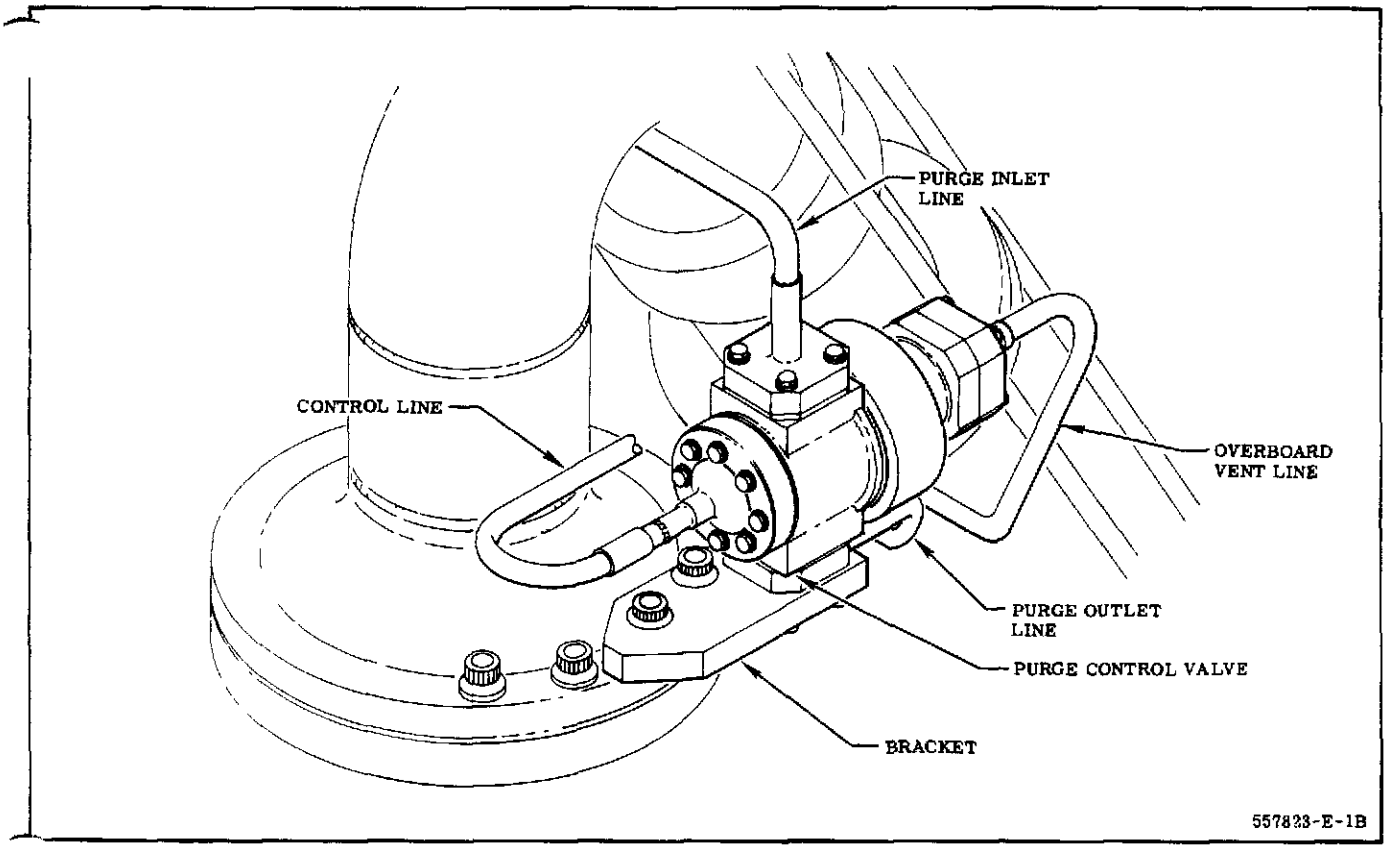


Figure 3-19. Purge Control Valve

(1) Oxidizer feed system handler 9016786

(2) Automatic Inert Gas Arc Welding Set G3128

(3) Single Head Special Tool Kit G3127

(4) Torque wrench capable of torquing to 48-73 inch-pounds

(5) Torque wrench capable of torquing to 135-630 inch-pounds

(6) Sling 9016779

(7) Chain-hoist 9027095 from engine components installer set 9026251

(8) Universal joint S8 from engine components installer set 9026251

(9) Extension bar SX-24 from engine components installer set 9026251

(10) Component handling cart 9026253 from engine components installer set 9026251

(11) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Welding tubes

(3) Connecting electrical connectors

(4) Torquing

(5) Safetywiring

c. Install handler on oxidizer high-pressure duct with straps attached to black hooks, elbow upward, and hoist socket approximately horizontal and pointing toward center of engine.

NOTE

If the launch tower umbilical arm is to be used for transporting the component into the stage, omit steps d through h.

d. Install chain-hoist to hoist boom and extend hoist boom through stage access door.

e. Install sling on handler and secure with ball-lock pin.

f. Lower hoist hook and attach to lifting ring of sling.

g. Using hoist, raise duct and transfer duct in through stage access door and place duct on protective pad.

h. Remove hoist from hoist boom and sling from handler.

i. Connect handler to hoist and secure with ball-lock pin. Position hoist at track station 12 for engine positions 1 through 4, or track station 20 for engine position 5.

j. Remove closures, as required during installation, to make connections.

k. Prior to installing oxidizer high-pressure duct, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

l. If oxidizer inlet orifice plate was removed, reinstall by positioning orifice plate and installing snapring.

m. Using hoist, move oxidizer high-pressure duct into position on engine.

n. Position purge control valve bracket on oxidizer high-pressure duct exit flange. Secure bracket and flange to oxidizer valve with bolts and washers. Tighten bolts fingertight.

o. On engines incorporating MD180 or MD181 change, install mainstage OK pressure switch and adapter plate. Torque adapter bolts to 55-65 inch-pounds.

p. Connect electrical connectors P20 and P26 to mainstage OK pressure switches.

q. Connect pressure tubes to pressure switches. Torque tube coupling nuts to 135-185 inch-pounds.

NOTE

Tie rods may be used to compress the ducts for ease of installation, to change the distance between the main oxidizer valve and the oxidizer turbopump flange a maximum of 0.75 inch.

r. Position bracket on oxidizer high-pressure duct inlet flange. Secure bracket and flange to oxidizer turbopump exit flange with bolts and washers. Tighten bolts fingertight.

s. Back off tie-rod nuts to remove all preloading.

t. Cross-torque bolts that secure oxidizer high-pressure duct to main oxidizer valve to 570-630 inch-pounds and safetywire.

u. Cross-torque bolts that secure oxidizer high-pressure duct to oxidizer turbopump flange to 361-399 inch-pounds and safetywire.

v. Remove handler from oxidizer high-pressure duct.

w. Disassemble track. (Refer to section II.)

x. Adjust tie-rod nuts until a 0.025-inch feeler gage fits snugly between tie-rod nut and washer at one end of each of the 3 tie rods.

y. While holding tie-rod nut on one end of tie rod, tighten nut on other end exactly 3 complete revolutions. Repeat this operation on other 2 tie rods and safetywire nuts to tie rods.

z. On engines not incorporating MD105 change, install seal and secure heat exchanger inlet tube to oxidizer high-pressure duct with bolts and washers. Cross-torque bolts to 48-53 inch-pounds and safetywire.

aa. Make sure oxidizer turbopump discharge pressure tube adapter is torqued to 67-73 inch-pounds. If there is an indication of undertorque, remove adapter from duct, replace seal, reinstall adapter, and torque adapter to 67-73 inch-pounds.

ab. Weld oxidizer turbopump discharge pressure tube.

ac. Install seal and secure gas generator xidizer bleed valve to oxidizer high-pressure duct with bolts and washers. Cross-torque bolts to 143-157 inch-pounds and safetywire.

ad. Connect electrical connectors P111 and P125.

ae. Refer to R-3825-3 for post-maintenance test.

3-69. REMOVING OXIDIZER HIGH-PRESSURE DUCT (SIVB STAGE).

a. Assemble track (refer to section II) for oxidizer high-pressure duct removal, as required for applicable stage. Install turntable with controls trailing.

b. Obtain the following equipment:

(1) Oxidizer feed system handler 9016786

(2) Single Head Special Tool Kit G3127

c. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

e. Remove bolts and washers that secure oxidizer bleed valve to oxidizer high-pressure duct. Remove seal. (See figure 3-18.)

f. Disconnect electrical connectors P111 and P125.

g. Using tube cutter from Single Head Special Tool Kit G3127, cut oxidizer turbopump discharge pressure tube.

h. On engines not incorporating MD105 change, remove bolts and washers that secure heat exchanger inlet tube to discharge duct. Remove seal.

i. Install closures on all open ports.

j. Install handler on oxidizer high-pressure duct with straps attached to black hooks, elbow upward, and hoist socket approximately horizontal and pointing toward center of engine.

k. Connect hoist to handler to support high-pressure duct and secure with ball-lock pin.

l. Remove bolts, washers, and bracket that secure high-pressure duct to oxidizer turbopump.

m. On engines incorporating MD180 or MD181 change, disconnect electrical connectors P20 and P26. Remove mainstage OK pressure switch and adapter plate.

n. Remove remaining bolts and washers that secure high-pressure duct to main oxidizer valve. (See figure 3-19.)

o. Make sure oxidizer high-pressure duct is free from engine; then move duct clear of engine. Remove seals.

p. If oxidizer inlet orifice plate is to be removed, remove snapring and lift out orifice plate.

q. Install closures on all open ports.

r. Using hoist, move oxidizer high-pressure duct to an accessible area near stage access door.

s. Remove duct from handler and manually carry oxidizer high-pressure duct from stage.

NOTE

The weight of the oxidizer high-pressure duct is 64 pounds.

3-70. INSTALLING OXIDIZER HIGH-PRESSURE DUCT (SIVB STAGE).

a. Obtain the following equipment:

(1) Oxidizer feed system handler 9016786

(2) Automatic Inert Gas Arc Welding Set G3128

(3) Single Head Special Tool Kit G3127

(4) Torque wrench capable of torquing to 48-73 inch-pounds

(5) Torque wrench capable of torquing to 135-630 inch-pounds

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

c. Manually carry oxidizer high-pressure duct into stage and install duct on handler with straps attached to black hooks and elbow upward. Orient duct in handler as installed on engine.

NOTE

The weight of the oxidizer high-pressure duct is 64 pounds.

d. Remove closures, as required during installation, to make connections.

e. Prior to installing oxidizer high-pressure duct, visually inspect threads in parent material for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

f. If oxidizer inlet orifice plate was removed, reinstall by positioning orifice plate and installing snapring.

g. Using hoist, move oxidizer high-pressure duct into position on engine.

h. Position purge control valve bracket on high-pressure duct exit flange. Secure bracket and flange to oxidizer valve with bolts and washers. Tighten bolts fingertight.

i. On engines incorporating MD180 or MD181 change, install mainstage OK pressure switch and adapter plate. Torque adapter bolts to 55-65 inch-pounds.

j. Connect electrical connectors P20 and P26 to mainstage OK pressure switches.

k. Connect pressure tubes to pressure switches. Torque tube coupling nuts to 135-185 inch-pounds.

NOTE

Tie rods may be used to compress the ducts for ease of installation, to change the distance between the main oxidizer valve and the oxidizer turbopump flange a maximum of 0.75 inch.

l. Position bracket on discharge duct inlet flange. Secure bracket and flange to oxidizer turbopump exit flange with bolts and washers. Tighten bolts fingertight.

m. Back off tie-rod nuts to remove all preloading.

n. Cross-torque bolts that secure discharge duct to main oxidizer valve to 570-630 inch-pounds and safetywire.

o. Cross-torque bolts that secure discharge duct to oxidizer turbopump flange to 361-399 inch-pounds and safetywire.

p. Remove handler from discharge duct.

q. Disassemble track. Refer to section II.

r. Adjust tie-rod nuts until a 0.025-inch feeler gage fits snugly between tie-rod nut and washer at one end of each of the 3 tie rods.

s. While holding tie-rod nut on one end of tie rod, tighten nut on other end exactly 3 complete revolutions. Repeat this operation on the other 2 tie rods and safetywire nuts to tie rods.

t. On engines not incorporating MD105 change, install seal and secure heat exchanger inlet tube to discharge duct with bolts and washers. Cross-torque bolts to 48-53 inch-pounds and safetywire.

u. Make sure oxidizer turbopump discharge pressure tube adapter is torqued to 67-73 inch-pounds. If there is an indication of undertorque, remove adapter from duct, replace seal, reinstall adapter, and torque adapter to 67-73 inch-pounds.

v. Weld oxidizer turbopump discharge pressure tube.

w. Install seal and secure gas generator oxidizer bleed valve to discharge duct with bolts and washers. Cross-torque bolts to 143-157 inch-pounds and safetywire.

x. Connect electrical connectors P111 and 125.

y. Refer to R-3825-3 for post-maintenance tests.

3-71. OXIDIZER TURBOPUMP.

3-72. The oxidizer turbopump may be removed and reinstalled, but not replaced without affecting engine calibration.

3-73. REMOVING OXIDIZER TURBOPUMP (SII STAGE).

a. Assemble track (refer to section II) around engine from which oxidizer turbopump is to be removed. Install turntable with controls leading, and position hoist at track station 15.5 for engine positions 1 through 4, or track station 16 for engine position 5.

b. Obtain the following equipment: (Items 8 through 12 and item 15 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Oxidizer heat exchanger handler 016790-11

(2) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4071, shelf 3

(3) Hook 9024600 from Engine Components Installer G4071, shelf 1

(4) Pin puller CJ-93 (Snap-On Tool Co)

(5) Torque wrench adapter T-5040045

(6) Single Head Special Tool Kit G3127

(7) Torque wrench capable of torquing to 12-110 inch-pounds

(8) Pickup adapter 9024547 from engine components installer set 9026251

(9) Hanger 9024543 from engine components installer set 9026251

(10) Chain-hoist 9027095 from engine components installer set 9026251

(11) Universal joint S8 from engine components installer set 9026251

(12) Extension bar SX-24 from engine components installer set 9026251

(13) Components handling cart 9026253 from engine components installer set 9026251

(14) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(15) Shackle G209-9-1/2

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

(4) Torquing

d. Install hook on hoist in position shown in figure 3-2, view A.

e. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

f. Remove oxidizer inlet duct for engine positions 1 through 4 (paragraph 3-64), and for engine position 5 in accordance with applicable stage procedures. Install handler 9026977 on oxidizer turbopump volute with handler arrow pointing toward oxidizer turbopump engine attach fitting. Using torque wrench adapter, cross-torque handler attach bolts to 90-110 inch-pounds. Install closure RX20714 on handler.

CAUTION

Electrical connectors P36 and P119 must not be disconnected from the propellant utilization valve, to avoid additional electrical checkout. The propellant utilization valve must be supported so that no strain is on electrical cables or connections.

g. Disconnect propellant utilization valve (figure 3-20) as follows:

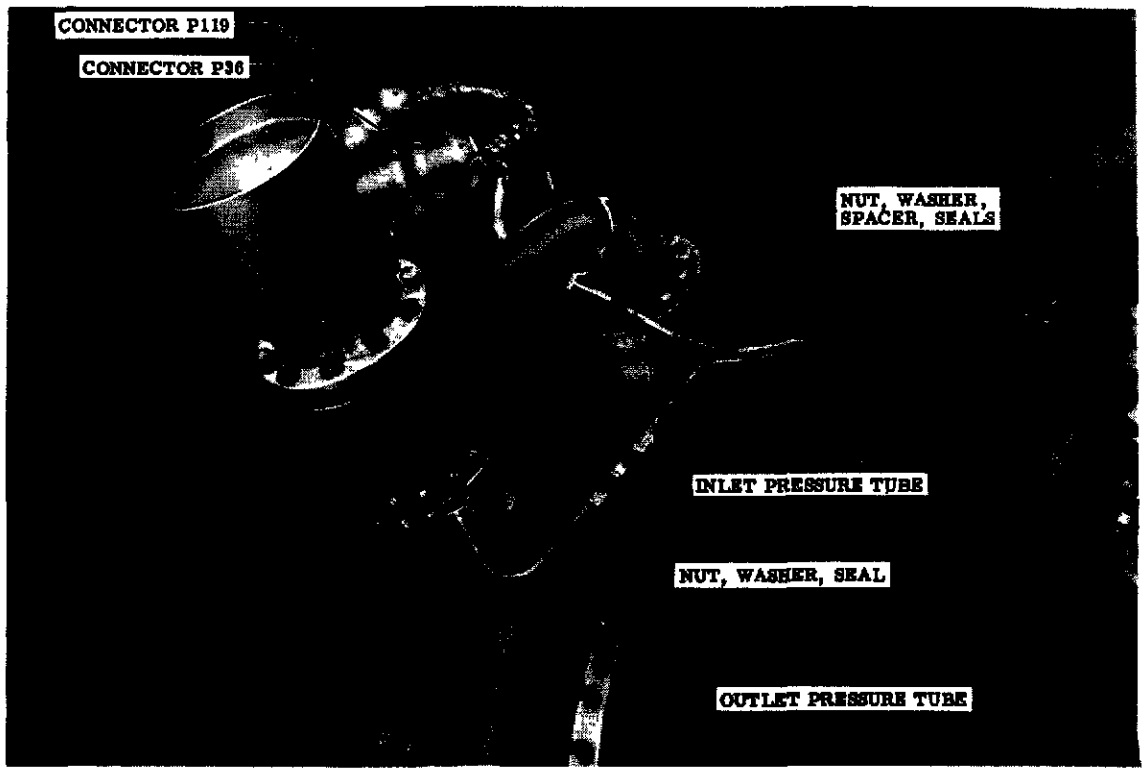


Figure 3-20. Propellant Utilization Valve

NOTE

On engines not incorporating MD153 change, the propeliant utilization valve may be reinstalled, but not replaced without affecting engine calibration. On engines incorporating MD153 change, the propellant utilization valve may be replaced without affecting engine calibration.

(1) Cut outlet pressure tube and inlet pressure tube.

(2) Remove nuts and washers that secure valve to turbopump. Remove valve, seals, and spacer.

(3) Install closures on all open ports.

h. Remove bolts, washers, and seal that secure oxidizer high-pressure duct to oxidizer turbopump. (See figure 3-21.)

i. Disconnect electrical connectors P113, P127, and P162.

j. Cut instrumentation and purge lines, leaving one inch of straight line downstream (engine side) of first bend past line support bracket on turbopump. Cut turbine seal purge line between line support bracket and orifice, as close to orifice as possible.

k. Cut oxidizer turbine inlet pressure tube.

l. Remove bolts, washers, brackets, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. (See figure 3-21.)

m. Install handler 9016790-11 on heat exchanger with end supports straddling bellows. handknob down, and hoist socket pointing toward center of engine.

n. Remove bolts and washers that secure bracket to oxidizer pump torque access plate.

o. Remove bolts and washers that secure heat exchanger to oxidizer turbopump.

p. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal at turbopump exhaust flange.

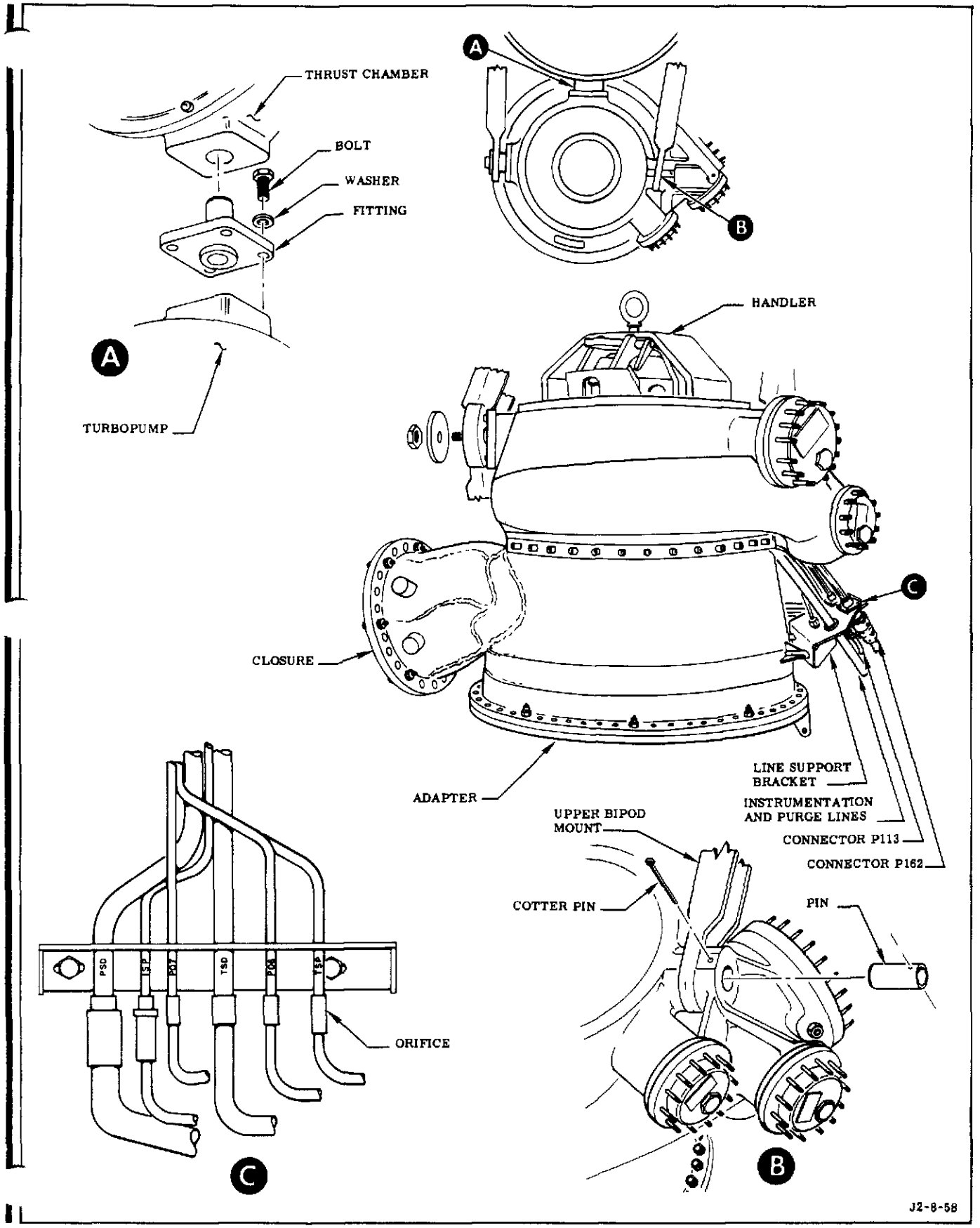


Figure 3-21. Oxidizer Turbopump

NOTE

If the launch tower umbilical arm is to be used for component removal from stage, omit steps r and s; otherwise, omit step q.

q. Connect hook on hoist to handler eyebolt, secure with ball-lock pin and support weight of turbopump.

r. Install pickup adapter to handler lifting eye.

s. Connect hoist to pickup adapter attached to handler, secure with ball-lock pin and support weight of turbopump.

t. Remove nut and washer that secure oxidizer turbopump to bipod mount. (See figure 3-21.)

u. Remove cotter pin and, using pin puller CJ-93 (Snap-On Tool Co), or equivalent, remove pin that secures oxidizer turbopump to upper bipod mount.

v. Move turbopump away from thrust chamber until turbopump center mount fitting is disengaged from bearing on thrust chamber. If fitting cannot be disengaged from thrust chamber, remove 4 bolts that secure fitting to turbopump; then remove turbopump and fitting from engine.

w. Install closures on all open ports.

NOTE

If the launch tower umbilical arm is to be used for transporting the component from the stage, omit steps y through ac; otherwise, omit step x.

x. Using hoist, transfer turbopump through stage access door and slowly lower into component handling cart.

y. Using hoist, slowly move turbopump to hanger and attach turbopump to hanger pickup adapter swivel.

z. Remove hook from hoist boom.

aa. Install chain-hoist on hoist boom.

ab. Attach hoist hook to pickup adapter, using shackle, and raise turbopump.

ac. Slowly move turbopump through stage access door and lower into component handling cart.

3-74. INSTALLING OXIDIZER TURBOPUMP (SII STAGE).

a. Obtain the following equipment: (Items 9 through 14 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4071, shelf 3

(2) Automatic Inert Gas Arc Welding Set G3128

(3) Single Head Special Tool Kit G3127

(4) Hook 9024600 from Engine Components Installer G4071, shelf 1

(5) Torque wrench capable of torquing to 12-110 inch-pounds

(6) Torque wrench capable of torquing to 223-525 inch-pounds

(7) Oxidizer heat exchanger handler 9016790-11

(8) Torque wrench adapter T-5040045

(9) Pickup adapter 9024547 from engine components installer set 9026251

(10) Hanger 9024543 from engine components installer set 9026251

(11) Chain-hoist 9027095 from engine components installer set 9026251

(12) Universal joint S8 from engine components installer set 9026251

(13) Extension bar SX-24 from engine components installer set 9026251

(14) Shackle G-209-9-1 2 or G-210-9-1 2 (Crosby-Laughlin, Inc), or equivalent

(15) Component handling cart 9026253 from engine components installer set 9026251

(16) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(17) Torque wrench adapter T-5044632

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Connecting electrical connectors

(3) Welding tubes

(4) Torquing

(5) Safetywiring

c. Prior to installing turbopump, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

d. Install handler 9026977 on oxidizer turbopump volute with arrow pointing toward oxidizer turbopump engine attach fitting. Using torque wrench adapter T-5040045, cross-torque handler attach bolts to 90-110 inch-pounds. Install closure RX20714 on handler.

NOTE

If the launch tower umbilical arm is used for transporting the components to the stage, omit steps e through l; otherwise, omit steps m through o.

e. Install pickup adapter on handler.

f. Position hoist on track near stage access door and install chain-hoist on hoist boom.

g. Move hoist boom through stage access door and lower hoist hook and attach to pickup adapter, using shackle.

h. Slowly raise turbopump and transfer turbopump through stage access door.

i. Move turbopump to hanger and attach turbopump to hanger, using pickup adapter swivel; secure with ball-lock pin.

j. Remove chain-hoist from hoist boom.

k. Install hook on hoist boom, as shown in figure 3-2, view A.

l. Connect hook on hoist boom to pickup adapter and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

m. Install hook on hoist boom, as shown in figure 3-2, view A.

n. Connect hook on hoist boom to handler lifting eye on fuel turbopump and secure hook latch with ball-lock pin. Support turbopump using hoist controls.

o. Slowly raise turbopump and transfer through stage access door.

p. Position hoist at track station 15.5 for engine positions 1 through 4, or track station 16 for engine position 5.

q. Remove closures, as required during installation, to make connections.

r. Install handler 9016790-11 on heat exchanger, with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

s. Compress heat exchanger bellows by turning handknobs on heat exchanger duct handler.

t. If fitting on turbopump center mount was removed, install 4 bolts and washers on fitting, install fitting on thrust chamber, and position turbopump on fitting. Torque bolts to 223-247 inch-pounds and safetywire.

u. Using hoist, move oxidizer turbopump into position on engine.

v. Install washer and nut securing oxidizer turbopump to bipod mount. Torque nut to 475-525 inch-pounds.

w. Install pin securing oxidizer turbopump to bipod mount and secure with cotter pin.

x. Remove handler from oxidizer turbopump.

y. Disassemble track. (Refer to section II.)

z. Install seal between turbopump manifold and heat exchanger.

aa. Loosen handknobs on heat exchanger handler and secure duct to turbopump with bolts, nuts, and washers. Tighten nuts fingertight.

ab. Remove heat exchanger handler.

ac. Install bracket on oxidizer pump torque access plate and secure with bolts, nuts, and washers. Install bolts fingertight.

ad. Cross-torque nuts at turbopump flange to 76-84 inch-pounds. Torque the 3 bolts that secure bracket to access plate to 40-50 inch-pounds and safetywire.

ae. Install seal between turbopump flange and fuel turbine exhaust flange. Secure flanges with bolts, washers, brackets, and nuts. Torque nuts to 67-73 inch-pounds.

af. Make sure adapter for oxidizer turbine inlet pressure tube is torqued to 67-73 inch-pounds. If slippage is indicated, remove adapter, replace seal, reinstall adapter, and torque to 67-73 inch-pounds.

ag. Weld oxidizer turbine inlet pressure tube and instrumentation and purge lines.

ah. Connect electrical connectors P113, P127, and P162.

ai. Install seal, washers, and bolts securing oxidizer high-pressure duct to oxidizer turbopump. Torque bolts to 361-399 inch-pounds.

aj. Install seal, bolts, and washers securing heat exchanger antiflood check valve to heat exchanger. Using torque wrench adapter T-5044632, torque bolts to 95-105 inch-pounds.

ak. Install propellant utilization valve (figure 3-20) as follows:

NOTE

On engines not incorporating MD153 change, the propellant utilization valve removed must be reinstalled. On engines incorporating MD153 change, the propellant utilization valve may be replaced.

(1) Install seals and spacer on oxidizer turbopump.

(2) Install propellant utilization valve on oxidizer turbopump and secure with washers and nuts. Cross-torque nuts to 65-72 inch-pounds.

(3) Make sure instrumentation adapters are torqued to 67-73 inch-pounds. If under torque is indicated, remove adapters, replace seals, reinstall adapters, and torque to 67-73 inch-pounds.

(4) Weld inlet and outlet pressure tubes.

(5) Make sure electrical connectors P36 and P119 are installed.

al. Install oxidizer inlet duct for engine positions 1 through 4 (paragraph 3-65), or for engine position 5 using applicable stage procedures.

am. Refer to R-3825-3 for post-maintenance test.

3-75. REMOVING OXIDIZER TURBOPUMP (SIVB STAGE).

a. Assemble track for oxidizer turbopump removed, as required for applicable stage. (Refer to section II.) Install turntable with controls leading.

b. Obtain the following equipment:

(1) Oxidizer heat exchanger handler 9016790-11

(2) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(3) Hook 9024600 from Engine Components Installer G4072, shelf 3

(4) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(5) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(6) Adapter 9026997 from engine components installer set 9026252

(7) Chain-hoist 9027095 from engine components installer set 9026252

(8) Component handling cart 9026253 from engine components installer set 9026252

(9) Extension bar SX24 from engine components installer set 9026252

(10) Universal joint S8 from engine components installer set 9026252

(11) Single Head Special Tool Kit G3127

(12) Torque wrench capable of torquing to 12-110 inch-pounds

(13) Pin puller CJ-93 (Snap-On Tool Co), or equivalent

(14) Torque wrench adapter T-5040045

c. Obtain closures, or suitable equivalent. (Refer to R-3825-4 for closures.) Closures must be certified clean for propellant system use.

d. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

(3) Cutting tubes

e. Remove oxidizer inlet duct (paragraph 3-63).

NOTE

It is not necessary to remove oxidizer inlet duct from the stage.

f. Install handler 9026977 and adapter 9026997 on oxidizer turbopump volute as follows:

(1) Install handler with arrow pointing toward oxidizer turbopump engine attach fitting. Place lifting eye in oxidizer turbopump lifting position.

(2) Using torque wrench adapter, cross-torque handler attach bolts to 90-110 inch-pounds.

(3) Remove screws that attach closure RX20714 on handler. Remove closure.

(4) Place adapter on closure and install closure and adapter on handler 9026977. Torque bolts to 50-70 inch-pounds.

CAUTION

Electrical connectors P36 and P119 must not be disconnected from the propellant utilization valve to avoid additional electrical checkout. The propellant utilization valve must be supported so that there is no strain on electrical cables or connections.

g. Disconnect propellant utilization valve (figure 3-20) as follows:

NOTE

On engines not incorporating MD153 change, the propellant utilization valve may be reinstalled, but not replaced without affecting engine calibration. On engines incorporating MD153 change, the propellant utilization valve may be replaced without affecting engine calibration.

(1) Cut outlet pressure tube and inlet pressure tube.

(2) Remove attaching hardware that secures valve to turbopump. Remove valve, seals, and spacer.

(3) Install closures on all open ports.

h. Remove attaching hardware and seal that secure oxidizer high-pressure duct to oxidizer turbopump. (See figure 3-21.)

i. Disconnect electrical connectors P113, P127, and P162.

j. Cut instrumentation and purge lines, leaving one inch of straight line downstream (engine side) of first bend past line support bracket on turbopump. Cut turbine seal purge line between line support bracket and orifice, as close to orifice as possible.

k. Cut oxidizer turbine inlet pressure tube.

l. Remove bolts, washers, brackets, and nuts that secure fuel turbine exhaust duct to oxidizer turbopump. (See figure 3-21.)

m. Install handler 9016790-11 on heat exchanger with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

n. Remove bolts and washers that secure bracket to oxidizer pump torque access plate.

o. Remove bolts and washers that secure heat exchanger to oxidizer turbopump.

p. Compress heat exchanger bellows by turning handknobs on heat exchanger handler. Remove seal at turbopump exhaust flange.

q. Install hook on hoist as shown in figure 3-2, view A.

r. Install pickup adapter on hook and secure hook latch with ball-lock pin.

s. Connect hoist to handler eyebolt, secure with ball-lock pin, and support weight of turbopump.

t. Remove nut and washer that secure oxidizer turbopump to bipod mount. (See figure 3-21.)

u. Remove cotter pin and, using pin puller CJ-93, remove pin that secures oxidizer turbopump to upper bipod mount.

v. Move turbopump away from thrust chamber until turbopump center mount fitting is disengaged from bearing on thrust chamber. If fitting cannot be disengaged from thrust chamber, remove 4 bolts that secure fitting to turbopump; then remove turbopump and fittings from engine.

w. Make sure turbopump is free of engine; then move turbopump clear of engine.

x. Install closures on turbopump and all open ports.

y. Assemble hanger in accessible area near stage access door.

z. Using hoist, move turbopump to hanger.

CAUTION

Raising the hoist boom above the indicated maximum height can damage equipment.

aa. Raise hoist until pickup adapter engages hanger shackle. Do not raise hoist above the indicated maximum height. If pickup adapter does not engage hanger shackle with hoist adjusted to maximum, adjust boom turnbuckle until pickup adapter engages hanger shackle.

ab. Remove ball-lock pin from hook, and remove hoist from hanger.

ac. Assemble elevated track for removal of oxidizer turbopump from stage. (Refer to section II.)

ad. Install chain-hoist on hoist and secure with ball-lock pin.

ae. Loosen internal wrenching bolt and remove hook from chain-hoist.

af. Move hoist into position to pick up turbopump.

ag. Make sure lifting adapter on turbopump adapter 9026997 is installed directly above the centerline chain LOX turbopump position.

ah. Connect chain-hoist chain to lifting adapter and torque internal wrenching bolt to 12-15 inch-pounds.

ai. Using hoist and chain-hoist, remove turbopump from hanger.

CAUTION

The turbopump must be restrained due to the limited access, to prevent damage to the turbopump and stage.

aj. Using hoist, move turbopump through stage access door. Manually restrain movement of turbopump when moving it through stage access door.

ak. Using chain-hoist and hoist, lower turbopump to component handling cart.

al. Install turbopump in cart and remove chain hoist from handler.

3-76. INSTALLING OXIDIZER TURBOPUMP (IVB STAGE).

a. Obtain the following equipment:

(1) LOX and fuel turbopump handler 9026977 from Engine Components Installer G4072, shelf 3

(2) Hook 9024600 from Engine Components Installer G4072, shelf 3

(3) Pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Adapter 9026997 from engine components installer set 9026252

(6) Chain-hoist 9027095 from engine components installer set 9026252

(7) Component handling cart 9026253 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Extension bar SX24 from engine components installer set 9026252

(10) Oxidizer heat exchanger handler 9016790-11

(11) Automatic Inert Gas Arc Welding Set G3128

(12) Single Head Special Tool Kit G3127

(13) Torque wrench capable of torquing to 12-110 inch-pounds

(14) Torque wrench capable of torquing to 223-525 inch-pounds

(15) Torque wrench adapter T-5040045

(16) Torque wrench adapter T-5044632

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

c. Prior to installing oxidizer turbopump, visually inspect threads in parent metal for damage and/or thread inserts for damage and correct installation. (Refer to R-3825-3.)

d. Install handler 9026977 and adapter on oxidizer turbopump volute as follows:

(1) Remove closure, and install handler with arrow pointing toward oxidizer turbopump engine attach fitting. Place lifting eye in oxidizer turbopump lifting position.

(2) Using torque wrench adapter T-5040045, cross-torque handler attach bolts to 90-110 inch-pounds.

(3) Remove screws that attach closure to handler. Remove closure.

(4) Place adapter on closure and install closure and adapter on handler. Cross-torque bolts to 50-70 inch-pounds.

(5) Make sure lifting adapter on turbopump adapter is directly above the centerline chain LOX turbopump position. Remove ball-lock pin and rotate adapter, if required.

e. Install chain-hoist on hoist and secure with ball-lock pin.

f. Connect chain-hoist chain-fitting to lifting adapter, and torque internal wrenching bolt (on chain fitting) to 12-15 inch-pounds.

g. Using chain-hoist and hoist, raise oxidizer turbopump from cart.

CAUTION

The turbopump must be restrained due to the limited access, to prevent damage to the turbopump and stage.

h. Using hoist, move oxidizer turbopump into stage. Manually restrain movement of oxidizer turbopump when moving it through stage access door.

i. Make sure pickup adapter is attached to hanger.

CAUTION

Raising the hoist boom above the indicated maximum height can damage the equipment.

j. Using hoist, move oxidizer turbopump to hanger, and raise hoist until handler lifting eye engages pickup adapter. Do not raise hoist above the indicated maximum height. If handler lifting eye does not engage pickup adapter with hoist adjusted to indicated maximum, adjust boom turnbuckle until handler lifting eye engages pickup adapter.

k. Secure oxidizer turbopump to hanger with ball-lock pin on pickup adapter.

l. Remove hoist and chain-hoist. Install chain-hoist hook on chain-hoist and torque internal wrenching bolt to 12-15 inch-pounds.

m. Disassemble elevated track (refer to section II).

n. Install hook on hoist. (See figure 3-2, view A.)

o. Position hoist and connect hook to pickup adapter and secure hook latch with ball-lock pin.

CAUTION

Raising the hoist boom above the indicated maximum height can damage the equipment.

p. Raise hoist and remove fuel turbopump from hanger. Do not raise hoist above indicated maximum height. Adjust boom turnbuckle, to obtain additional hoist height.

q. Using hoist, move oxidizer turbopump to engine.

r. Remove closures, as required during installation, to make connections.

s. Install handler 9016790-11 on heat exchanger with end supports straddling bellows, handknob down, and hoist socket pointing toward center of engine.

t. Compress heat exchanger bellows by turning handknobs on heat exchanger duct handler.

u. If fitting on turbopump center mount was removed, install 4 bolts and washers on fitting, install fitting on thrust chamber, and position turbopump on fitting. Torque bolts to 223-247 inch-pounds and safetywire.

v. Using hoist, move oxidizer turbopump into position on engine.

w. Install washer and nut securing oxidizer turbopump to bipod mount. Torque nut to 475-525 inch-pounds.

x. Install pin securing oxidizer turbopump to bipod mount and secure with cotter pin.

y. Remove handler from oxidizer turbopump. Install closure.

z. Disassemble track. (Refer to section II.)

aa. Install seal between turbopump manifold and heat exchanger.

ab. Loosen handknobs on heat exchanger handler and secure duct to turbopump with bolts, nuts, and washers. Tighten nuts fingertight.

ac. Remove heat exchanger handler.

ad. Install bracket on oxidizer pump torque access plate and secure with bolts, nuts, and washers. Install bolts fingertight.

ae. Cross-torque nuts at turbopump flange to 76-84 inch-pounds. Torque the 3 bolts securing bracket to access plate to 40-50 inch-pounds and safetywire.

af. Install seal between turbopump flange and fuel turbine exhaust flange. Secure flanges with bolts, washers, brackets, and nuts. Torque nuts to 67-73 inch-pounds.

ag. Make sure adapter for oxidizer turbine inlet pressure tube is torqued to 68-73 inch-pounds. If slippage is indicated, remove adapter, replace seal, reinstall adapter, and torque to 68-73 inch-pounds.

ah. Weld oxidizer turbine inlet pressure tube and instrumentation and purge lines.

ai. Connect electrical connectors P113, P127, and P162.

aj. Install seal, washers, and bolts securing oxidizer high-pressure duct to oxidizer turbopump. Torque bolts to 361-399 inch-pounds.

ak. Install seal, bolts, and washers securing heat exchanger antiflood check valve to heat exchanger. Using torque wrench adapter T-5044632, torque bolts to 95-105 inch-pounds.

NOTE

On engines not incorporating MD153 change, the propellant utilization valve removed must be reinstalled. On engines incorporating MD153 change, the propellant utilization valve may be replaced.

al. Install propellant utilization valve (figure 3-20) as follows:

(1) Install seals and spacer on oxidizer turbopump.

(2) Install propellant utilization valve on oxidizer turbopump and secure with washers and nuts. Cross-torque nuts to 65-72 inch-pounds.

(3) Make sure instrumentation adapters are torqued to 67-73 inch-pounds. If slippage is indicated, remove adapters, replace seals, reinstall adapters, and torque to 67-73 inch-pounds.

(4) Weld inlet and outlet pressure tubes.

(5) Make sure electrical connectors P36 and P119 are installed.

am. Install oxidizer inlet duct. (Refer to paragraph 3-64.)

an. Refer to R-3825-3 for post-maintenance tests.

3-77. PRIMARY FLIGHT INSTRUMENTATION PACKAGE.

3-78. The primary flight instrumentation package may be replaced without affecting engine calibration.

3-79. REMOVING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (SII STAGE). The weight of the primary flight instrumentation package (approximately 32 pounds) does not require use of Engine Components Installer G4071 (SII stage) or G4072 (SIVB stage). The following procedure, using the engine components installer, is presented in the event a heavier component, requiring the use of the installer, is being handled concurrently with the primary instrumentation package.

a. Obtain the following equipment:

(1) Primary flight instrumentation handler 9026942 from Engine Components Installer G4071, shelf 3

(2) Single Head Special Tool Kit G3127

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

c. Obtain closures for electrical connectors and tube ends. Closures must be certified clean for use in a propellant system.

d. Disconnect electrical connectors P100, P101, P102, P103, and P104. On engines incorporating MD233 change, connector P102 has been removed.

e. Remove bolts and washers that secure accumulator hose and filter to instrumentation package. Remove hose, filter, and seals. (See figure 3-22.)

f. Cut instrumentation tubes.

g. Remove bolts and washers that secure bonding wire to clevis.

h. Install handler on primary flight instrumentation package with cutout engaging accumulator hose connection boss, and secure strap latches with ball-lock pin.

i. Support primary flight instrumentation package by connecting boom to handler 9026942 and securing with ball-lock pin.

j. Remove bolts, washers, spacers, bracket, and nuts that secure instrumentation package to strut and clevises. Note position of spacers.

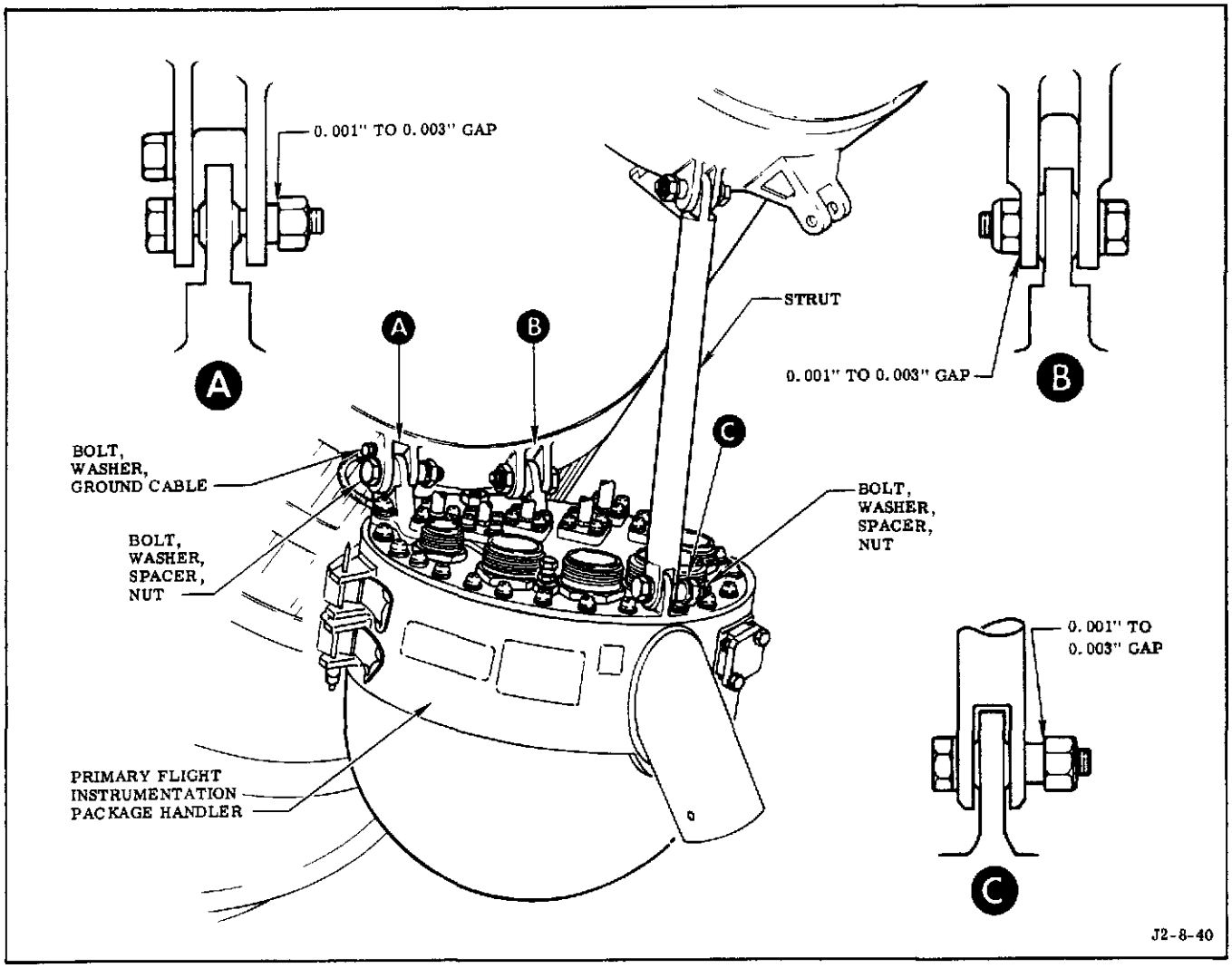


Figure 3-22. Primary Flight Instrumentation Package

bracket, and washers for reinstallation. Remove package from thrust chamber.

k. Install covers and closures on electrical connectors and tube ends.

l. Using hoist, transfer primary flight instrumentation package to stage access door. Remove package from handler and manually transfer package from vehicle.

3-80. INSTALLING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (SII STAGE).

a. Obtain the following equipment and material:

(1) Primary flight instrumentation handler 9026942 from Engine Components Installer G4071, shelf 3

(2) Torque wrench capable of torquing to 27-62 inch-pounds

(3) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(4) Silicon-carbide abrasive cloth or paper, 320-grit or finer

(5) Automatic Inert Gas Arc Welding Set G3128

(6) Single Head Special Tool Kit G3127

(7) Milliohmmeter No. 670A (Shallcross Mfg Co). or equivalent

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Connecting electrical connectors

(3) Welding tubes

(4) Torquing

(5) Safetywiring

c. Install handler on primary flight instrumentation package with cutout engaging accumulator hose connection boss, and secure strap latches with ball-lock pin.

d. Connect handler to boom and secure with ball-lock pin. Position hoist at track station 13 for engine positions 1 through 4, or track station 20 for engine position 5.

e. Remove closures, as required during installation, to make connections.

f. Using hoist, move primary flight instrumentation package into position on engine.

g. Aline package with mounting clevises and strut. Install bolts, spacers, washers, bracket, and nuts. Tighten nuts until a 0.001- to 0.003-inch gap exists between nut and adjoining washer.

h. Remove handler from primary flight instrumentation package.

i. Disassemble track. (Refer to section II.)

NOTE

To prevent corrosion, steps j through m must be completed within 24 hours.

j. Using abrasive cloth, clean all contact surfaces of ground cable terminal and its mating port of all protective finishes and foreign material.

k. Connect ground cable to clevis with bolt and washer. Torque bolt to 27-33 inch-pounds and safetywire.

l. Check resistance between primary flight instrumentation package and thrust chamber. Resistance must not exceed 100 milliohms.

m. Apply a coating of lacquer, premixed with blue dye, on bonding area.

n. Weld instrumentation tubes.

o. Connect electrical connectors P100, P101, P102, P103, and P104. On engines incorporating MD233 change, connector P102 has been removed.

p. Install 2 seals, filter, and accumulator hose with bolts and washers. Install recessed side of filter next to instrumentation package. Torque bolts to 56-62 inch-pounds and safetywire.

q. If accumulator hose contacts electrical cable (electrical cable to P3 connector), apply 2 layers of tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc) to electrical cable in area where hose and cable contact.

NOTE

It is permissible for the accumulator hose to contact the taped portion of the electrical cable.

r. Refer to R-3825-3 for post-maintenance test.

3-81. REMOVING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (SIVB STAGE). The weight of the primary flight instrumentation package (approximately 32 pounds) does not require use of Engine Components Installer G4072. The following procedure, using the engine components installer, is presented in the event the oxidizer high-pressure duct, requiring the use of the installer, is to be removed concurrently with the primary flight instrumentation package.

a. Obtain the following equipment:

(1) Primary flight instrumentation handler 9026942 from Engine Components Installer G4072, shelf 3

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (SIB vehicle) or 9027084-11 (SV vehicle) from Engine Components Installer G4072, shelf 3

(4) Single Head Special Tool Kit G3127

(5) Component handler universal lifting sling 9016779

b. Obtain closures for electrical connectors and tube ends. Closures must be certified clean for use in a propellant system.

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures secured with threaded fasteners

(2) Disconnecting electrical connectors

(3) Cutting tubes

d. Disconnect electrical connectors P100, P101, P102, P103, and P104. On engines incorporating MD233 change, connector P102 has been removed.

e. Remove bolts and washers that secure accumulator hose and filter to primary instrumentation package. Remove hose, filter, and seals. (See figure 3-22.)

f. Cut instrumentation tubes.

g. Remove bolts and washers that secure ground cable to clevis.

h. Install sleeve, extension, and handler on hoist. (See figure 3-2, view G.) Position extension in ninth (farthest from extension turnbuckle) positioning hole. Secure with ball-lock pin.

i. Manipulate hoist to lower handler through opening in which lower work platform is installed and orient handler with primary flight instrumentation package.

j. Attach handler on primary flight instrumentation package with cutout engaging accumulator hose connection boss. (See figure 3-22.) Wrap handler strap around package and secure strap latches with ball-lock pin.

CAUTION

A minimum of one thread must be evident in turnbuckle adjusting barrel to make sure turnbuckle operates safely.

k. Support primary flight instrumentation package by manipulation of hoist and turnbuckle on extension. If turnbuckle is extended, do not extend it beyond a minimum of one thread evident in turnbuckle barrel. Make sure side load does not exist on primary flight instrumentation package.

l. Remove attaching hardware that secures primary flight instrumentation package to strut and clevises.

m. Install covers and closures on electrical connectors and tube ends.

CAUTION

A minimum of one thread must be evident in the turnbuckle adjusting barrel to make sure the turnbuckle operates safely.

n. Make sure primary flight instrumentation package is free of engine; then, with hoist and extension turnbuckle, move primary flight instrumentation package clear of engine and through opening in which lower work platform is installed. Adjust turnbuckle to effect a narrow profile to aid in raising package to stage work deck.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the primary flight instrumentation package to the stage work platform; therefore, it may be necessary for a technician to guide the package and to assist the hoist operator.

o. Using hoist, move primary flight instrumentation package to an accessible area near stage access door.

p. Remove handler (with primary flight instrumentation package attached) from hoist and temporarily place on protective pad. Install sling on handler and secure with ball-lock pin.

NOTE

The combined weight of the primary flight instrumentation package, sling, and handler is approximately 40 pounds.

q. Using lifting eye on sling, manually carry primary flight instrumentation package from stage.

3-82. INSTALLING PRIMARY FLIGHT INSTRUMENTATION PACKAGE (SIVB STAGE).

a. Obtain the following equipment and materials:

(1) Primary flight instrumentation handler 9026942 from Engine Components Installer G4072, shelf 3

(2) Extension 9027080 from Engine Components Installer G4072, shelf 5

(3) Sleeve 9027084 (SIB vehicle) or 9027084-11 (SV vehicle) from Engine Components Installer G4072, shelf 3

(4) Component handler universal lifting sling 9016779

(5) Torque wrench capable of torquing to 27-62 inch-pounds

(6) Silicon-carbide abrasive cloth or paper, 320-grit or finer

(7) Milliohmmeter No. 670A (Shallcross Mfg Co), or equivalent

(8) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(9) Single Head Special Tool Kit G3127

(10) Automatic Inert Gas Arc Welding Set G3128

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Performing in-place tube welds

(3) Torquing

(4) Safetywiring

c. Manually carry primary flight instrumentation package into vehicle and place on protective pad. A suggested method of handling the primary flight instrumentation package is as follows:

(1) Install handler on package with cutout engaging accumulator hose connection boss.

(2) Wrap handler straps around package and secure strap latches with ball-lock pin.

(3) Attach sling on handler and secure with ball-lock pin.

NOTE

The combined weight of primary flight instrumentation package, sling, and handler is approximately 40 pounds.

d. Install sleeve and extension on hoist. (See figure 3-2, view G.) Position extension in ninth (farthest hole from extension turnbuckle) positioning hole. Secure with ball-lock pin.

e. Install handler on hoist extension. If handler is installed on primary flight instrumentation package (step c), remove sling. If handler is not installed, install handler as outlined in step c, except do not install sling.

CAUTION

A minimum of one thread must be evident in turnbuckle adjusting barrel to make sure turnbuckle operates safely.

f. Using hoist, move primary flight instrumentation package to engine position, lower through opening in which lower work platform is installed, and position on engine. Adjust turnbuckle, to effect a narrow profile to aid in lowering package to engine.

NOTE

The hoist operator may not have adequate visibility to safely manipulate the primary flight instrumentation package to the engine; therefore, it may be necessary for a technician to guide the package and to assist the hoist operator.

g. Remove closures, as required during installation, to initiate connections.

h. Aline package with mounting clevises and strut. Install bolts, washers, spacers, brackets, and nuts. Tighten nuts until 0.001- to 0.003-inch gap exists between nut and washer. (See figure 3-22.)

i. Remove handler from primary flight instrumentation package.

j. Remove handler, extension, and sleeve from hoist. Disassemble track. (Refer to section II.)

NOTE

To prevent corrosion, steps k through n must be completed within 24 hours.

k. Using abrasive cloth, clean all contact surfaces of ground cable terminal and its mating part of all protective finishes and foreign material.

l. Connect ground cable to clevis with bolt and washer. Torque bolt to 27-33 inch-pounds and safetywire.

m. Check resistance between primary flight instrumentation package and thrust chamber. Resistance must not exceed 100 milliohms.

n. Apply a coating of lacquer, premixed with blue dye, on bonding area.

o. Weld instrumentation tubes.

p. Connect electrical connectors P100, P101, P102, P103, and P104. On engines incorporating MD233 change, connector P102 has been removed.

q. Install 2 seals, filter, and accumulator hose with bolts and washers. Install recessed side of filter next to instrumentation package. Torque bolts to 56-62 inch-pounds and safetywire.

NOTE

It is permissible for the accumulator hose to contact the taped portion of the electrical cable.

r. If accumulator hose contacts electrical cable (electrical cable to P3 connector), apply 2 layers of tape 602 (Moxness Products, Inc) or tape 2650 (Johnson and Johnson, Inc) to electrical cable in area where hose and cable contact.

s. Refer to R-3825-3 for post-maintenance tests.

3-83. THRUST CHAMBER INJECTOR.

3-84. The thrust chamber injector may be removed and reinstalled but not replaced without affecting engine calibration.

3-85. REMOVING THRUST CHAMBER INJECTOR (SII STAGE).

a. Assemble track (refer to section II) around engine from which thrust chamber injector is to be removed. Install turntable and boom with controls leading, and position hoist at track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

b. Obtain the following equipment: (Items 2 through 7, and 11 are not required if the launch tower umbilical arm is to be used for transporting the component from the stage.)

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(2) Engine component handler 9024539 from engine components installer set 9026251

(3) Engine component pickup adapter 9024547 from engine components installer set 9026251

(4) Chain-hoist 9027095 from engine components installer set 9026251

(5) Universal joint S8 from engine components installer set 9026251

(6) Extension bar SX-24 from engine components installer set 9026251

(7) Engine component hanger 9024543 from engine components installer set 9026251

(8) Component handling cart 9026253 from engine components installer set 9026251

(9) Guide pins (two required) (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(10) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical arm)

(11) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc) or equivalent

(12) Torque wrench capable of torquing to 45-185 inch-pounds

(13) Electrical interface support 9024460

(14) Fluid lines interface support 9020628

(15) Fluid level, 4-6 inches long

(16) Single Head Special Tool Kit G3127

(17) Adapter T-5044412

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

(4) Torquing

d. Obtain closures, or suitable equivalent, for main oxidizer valve, start tank vent-and-relief valve, augmented spark igniter valve, ıgment spark igniter and gimbal. (Refer to -3825-4 for closures.) Closures must be certified clean for use in a propellant system.

e. Remove fuel inlet duct (paragraph 3-19) and oxidizer inlet duct (paragraph 3-61) for engine positions 1 through 4; for engine position 5, ducts from engine in accordance with applicable stage disconnect procedures.

f. Remove oxidizer high-pressure duct (paragraph 3-67).

NOTE

Steps g through k outline purge control valve removal.

- The purge control valve may be replaced without affecting engine calibration.

g. Cut purge inlet line.

h. Cut control line, purge outlet line, overboard vent line, and main oxidizer valve sequence control valve outlet line below flange joint of oxidizer dome and thrust chamber. ɜe figure 3-23.)

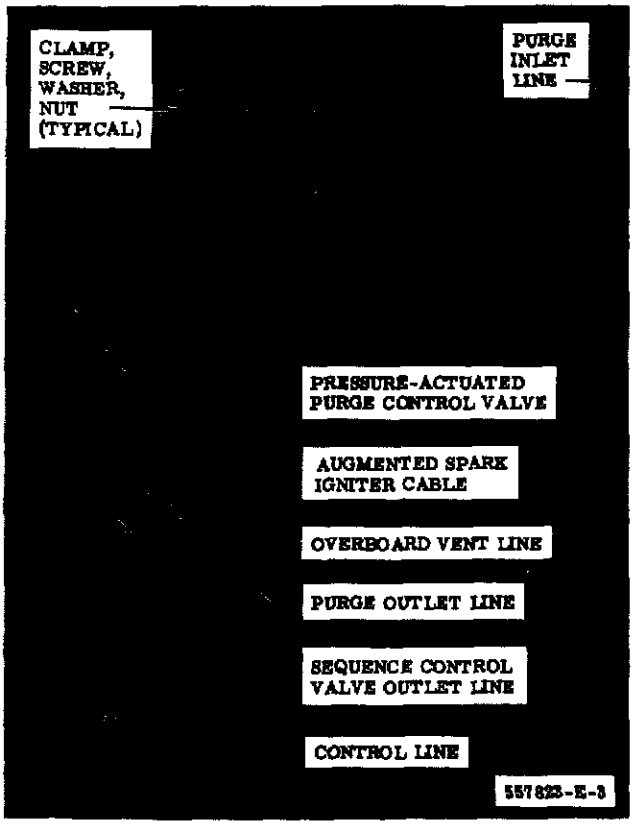


Figure 3-23. Purge Control Valve Removal

i. Remove screws, washers, and nuts that secure igniter cable and clamps to purge control valve. (See figure 3-23.)

j. Remove bolt, washer, nut, and clamp that secure control line.

k. Remove purge control valve and support bracket from engine.

l. Install closures on all open ports.

m. Disconnect electrical connectors P115 and P120. (See figure 3-24.)

n. Remove bolts and washers that secure augmented spark igniter oxidizer line to augmented spark igniter valve. (See figure 3-24.)

o. Remove bolts and washers that secure flanges to the following ports on the main oxidizer valve: pre-stage inlet, sequence control valve inlet, sequence control valve outlet, opening control port, and closing control port. Retain orifice removed from opening control port, for reinstallation.

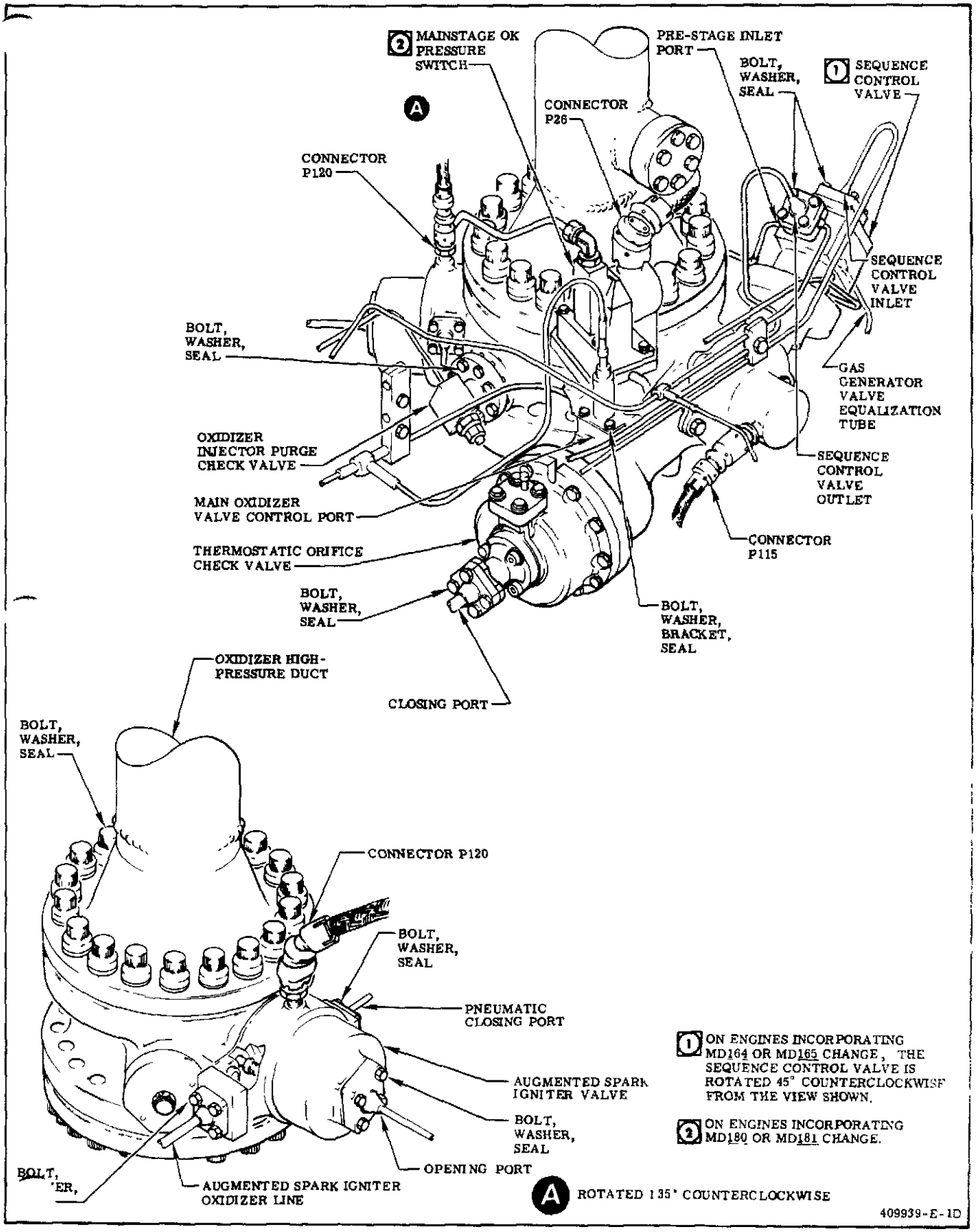


Figure 3-24. Main Oxidizer Valve

p. Cut gas generator pressure equalization tube.

q. Disconnect electrical connectors P20 and P26 and pressure lines from mainstage OK pressure switches. On engines incorporating MD180 or MD181 change, remove bolts and washers that secure mainstage OK pressure switch adapter plate to oxidizer dome inlet. Remove seal.

r. Using adapter T-5044412, remove bolts and washers that secure main oxidizer valve to oxidizer dome inlet.

s. Remove main oxidizer valve and seal.

t. Install closures on oxidizer valve and all open ports.

u. Measure pressure in igniter cables as outlined in R-3825-1B; then depressurize igniter cables by backing off pressurizing valve locknut (see figure 3-3) 1-3 turns and depressing valve core.

WARNING

Applying electrical power to the engine when connecting or disconnecting electrical connectors and/or igniter cables or when igniter cables are disconnected can cause electrical arcing, resulting in injury to personnel and damage to equipment.

v. Make sure all electrical power to engine is turned off.

w. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses, and install closures on all open ports.

x. Remove bolts that secure pressurizing valve mounting bracket to bell housing of gas generator igniter cables and remove bracket.

CAUTION

Care must be taken throughout the following procedures, or damage to the igniter cable pressurizing tubes can result.

y. Remove remaining bolts that attach gas generator igniter cables to electrical control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on cable bell housing can damage the igniter cable and electrical control assembly.

z. Remove gas generator igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step aa immediately.

aa. Install support ST3950166RKL001 and closures on igniter NA5-27448 as follows: (Install closures only on all other igniter cables and exciters.)

(1) Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbored holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

ab. Install closures on igniter cables 651389 and 651390 and on exciters.

ac. Temporarily secure cables to engine.

ad. Disconnect electrical connectors P1, P2, and P3.

ae. Remove nut, washers, and screws from augmented spark igniter cable pressurizing tube support clamps.

af. Remove bolts that secure augmented spark igniter cables to control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on the cable bell housing can damage the igniter cable and electrical control assembly.

ag. Remove augmented spark igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step ah immediately.

ah. Install support ST3950166RKL001 and closure on igniter cable NA5-27448 as follows: (Install closures only on all other igniter cables and on exciters.)

(1) Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbore holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

ai. Remove igniter cable support clamps. Note position of clamps for reinstallation.

aj. On engines not incorporating MD338 change, disconnect electrical connector P19 from ignition detector probe on injector dome. On engines incorporating MD330 change, disconnect electrical connector P165 from combustion temperature probe on injector dome.

ak. On engines not incorporating MD327, MD328, MD329, MD332 or MD344 change, cut safetywire and remove bolts and washers that secure fuel probe line to augmented spark igniter fuel manifold and to thrust chamber. (See figure 3-25.) Remove seal. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, cut safetywire and remove bolts and washers that secure augmented spark igniter fuel line to lower fuel line flange. Remove seal.

al. Disconnect electrical connector P131 from temperature transducer on spark igniter fuel manifold. Remove transducer and install closure.

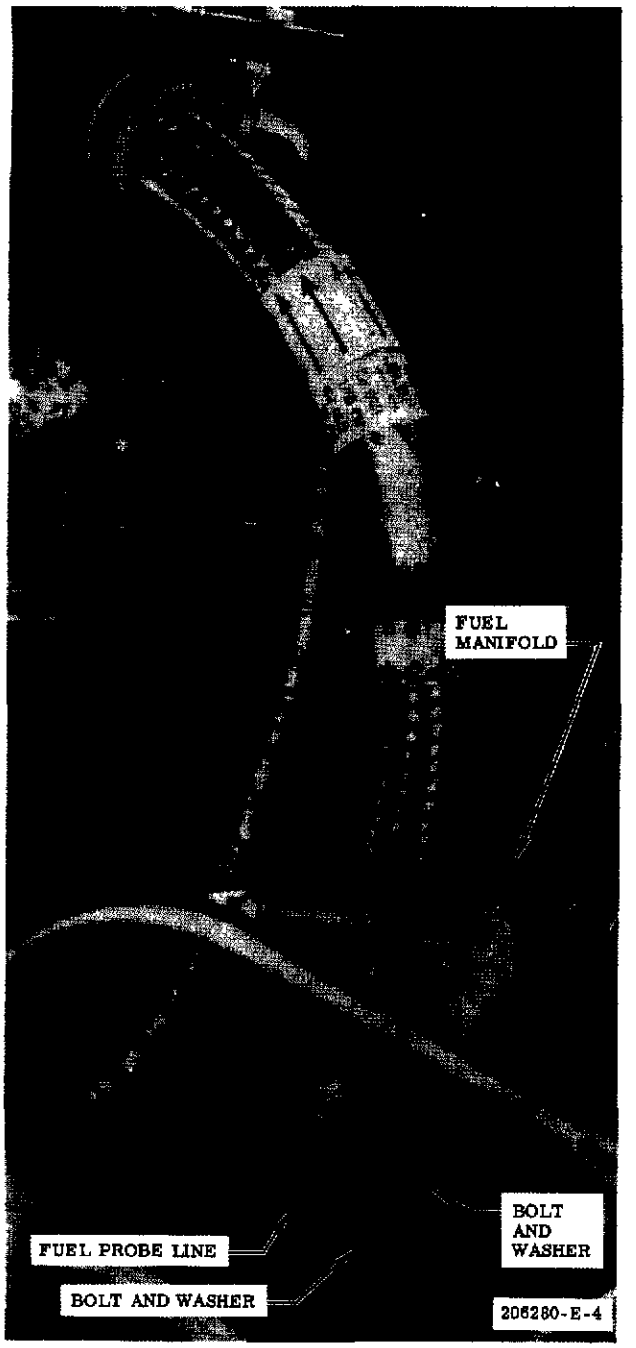


Figure 3-25. Fuel Manifold

am. On engines not incorporating MD150 or MD192 change, cut augmented spark igniter pressure instrumentation tube.

NOTE

On engines incorporating MD150 change, the augmented spark igniter pressure instrumentation tube is capped; on engines incorporating MD192 change, the tube is removed.

an. Install closures on all open ports.

WARNING

Removing start tank components before system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

ao. Prior to removing start tank vent-and-relief valve, make sure system is depressurized and has been purged in accordance with purge procedures in R-3825-3, since the last time fuel was introduced into system.

NOTE

Steps ap through ar outline start tank vent-and-relief valve removal.

ap. Remove bolts, washers, and nuts that secure vent line bracket to support. (See figure 3-12.)

aq. Remove screw, washer, and nut that secure control line clamp to bracket.

ar. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

as. Install closures on all open ports.

at. Temporarily reposition and secure start tank vent-and-relief valve, to provide vertical access for removal of thrust chamber and injector.

au. Install electrical and fluid lines interface supports on engine. Disconnect electrical and fluid interface lines from stage, and attach the disconnected lines to the interface supports.

av. Remove gimbal boot.

aw. Install engine lowering system for engine from which injector is to be removed. (Refer to section II.) Engine must be lowered a maximum of 7 inches to remove injector.

ax. Adjust lower end of turnbuckle to position shown in figure 3-26.

ay. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts, to check level of engine.

az. Remove bolts and washers that secure customer-connect tube support clevis to thrust chamber dome.

ba. Loosen bolts that secure thrust chamber injector to thrust chamber one turn.

CAUTION

While the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing lower-end adjustment can induce moments into the turnbuckles that can bend and may break the turnbuckles.

bb. Make sure lower end of turnbuckles are positioned to dimension shown in figure 3-26; then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1/16 inch.

bc. Slowly lower engine by extending turnbuckles until a 1/4 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

bd. Adjust mechanism at top of turnbuckles to position turnbuckles vertically in 2 planes, 90 degrees apart. Use fluid level.

be. Remove nuts and bolts that formerly secured gimbal to stage.

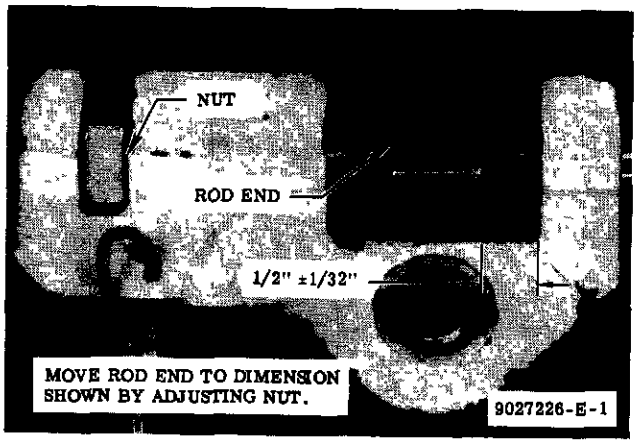


Figure 3-26. Required Turnbuckle Position for Engine Lowering

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering slowly and carefully.

bf. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway, at which time, reduce rotation of turnbuckles to 1/6-turn increments until gimbal is clear. Monitor the gimbal while lowering, for evidence of binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

NOTE

One flat of the turnbuckles adjusting barrel may be marked as an index to keep count of turnbuckle rotations.

bg. Lower engine a maximum of 7 inches by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other.

bh. Disassemble handler 9027263 by separating extension from handler. Attach extension to hoist and straddle gimbal with handler as shown in figure 3-10. Handler is to be positioned to extend over engine between oxidizer dome inlet flange and oxidizer turbopump.

bi. Loosen knobs that secure 4 tubes of handler and adjust tubes until they contact dome (with handler in approximately level position); then tighten knobs fingertight.

bj. Attach hoist with extension (step bh) to handler. Manipulate turntable and boom to effect as short a coupling between extension and handler portions of handler 9027263 as possible, and pin the 2 parts of handler together.

bk. Remove bolts and washers that secure thrust chamber injector to thrust chamber.

bl. Install guide pins in thrust chamber-to-injector boltholes adjacent to the lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and add unnecessary loads to the hoisting equipment.

bm. Using hoist, life thrust chamber injector from thrust chamber. Keep lift vertical by coordinating lateral and/or longitudinal adjustment of turntable controls with hoist boom vertical controls.

bn. After thrust chamber injector is clear of thrust chamber, remove guide pins.

bo. Temporarily remove safety cable attached to oxidizer turbopump support strut.

bp. Using hoist, move thrust chamber injector clear of engine.

bq. Reinstall safety cable to oxidizer turbopump support strut.

br. Install closures on all open ports.

NOTE

If the launch tower umbilical arm is to be used to transport the component from the stage, omit steps bs through bv.

bs. Install handler 9024539 on gimbal and attach pickup adapter to handler eyebolt.

bt. Using hoist, transfer gimbal and injector to hanger by attaching pickup adapter swivel to hanger with ball-lock pin.

bu. Remove handler 9027263 from hoist ɔm and install chain-hoist to hoist boom.

bv. Attach hoist hook to pickup adapter using a shackle and slowly raise the gimbal and injector.

bw. Using hoist, slowly move gimbal and injector through stage access door and lower into component handler cart.

bx. Maintain or note length of gimbal and injector handler for gimbal reinstallation.

3-86. INSTALLING THRUST CHAMBER INJECTOR (SII STAGE).

a. Obtain the following tools and equipment: (Items 9 through 14, and 18 are not required if the launch tower umbilical arm is to be used for transporting the component to the stage.)

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4071, shelf 2

(2) Fluid level, 4-6 inches long

(3) Automatic Inert Gas Arc Welding Set G3128

(4) Single-Head Special Tool Kit G3127

(5) Torque wrench capable of torquing to 6-126 inch-pounds

(6) Torque wrench capable of torquing to 145-630 inch pounds

(7) Torque wrench capable of torquing to 725-775 inch-pounds

(8) Adapter T-5044412

(9) Engine component handler 9024539 from engine components installer set 9026251

(10) Engine component pickup adapter 9024547 from engine components installer set 9026251

(11) Chain-hoist 9027095 from engine components installer set 9026251

(12) Universal joint S8 fron. engine components installer set 9026251

(13) Extension bar SX-24 from engine components installer set 9026251

(14) Engine component hanger 9024543 from engine components installer set 9026251

(15) Component handling cart 9026253 from engine components installer set 9026251

(16) Ramp 9026255 from engine components installer set 9026251 (three required for use on launch tower umbilical tower)

(17) Guide pins, (two required) (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(18) Shackle G-209-9-1/2 or G-210-9-1/2 (Crosby-Laughlin, Inc), or equivalent

(19) Blue-tinted lacquer ST0125RB0003 (Rocketdyne)

(20) Sealing compound RB0140-005 (Rocketdyne)

(21) Abrasive cloth, 320-grit or finer.

(22) FS1281 grease (Dow Corning Corp)

(23) Molykote Z powder (Dow Corning Corp)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Removing closures

(2) Connecting electrical connectors

(3) Welding tubes

(4) Torquing

(5) Safetywiring

c. Remove closures, as required during installation, to make connections.

NOTE

If the launch tower umbilical arm is to be used to transport component to the stage, omit steps d through k.

d. Install handler 9024539 on gimbal, and attach pickup adapter to handler eyebolt. Torque bolts to 145-185 inch pounds.

e. Install chain-hoist on hoist boom and extend hoist boom through stage access door.

f. Lower hoist hook and attach to pickup adapter, using shackle.

g. Using hoist and chain-hoist, raise injector and transfer injector through stage access door and attach gimbal and injector to hanger with pickup adapter swivel and ball-lock pin.

h. Remove chain-hoist from hoist boom.

i. Secure gimbal and thrust chamber injector in handler 9027263 as shown in figure 3-10.

j. Connect hoist to handler 9027263.

k. Using hoist, lift gimbal and injector from hanger. If installed, remove handler 9024539 and pickup adapter from gimbal.

l. Install inner thrust chamber injector to thrust chamber metal O-ring seal on thrust chamber injector.

m. Place thrust chamber injector-to-thrust chamber pressure-actuated seal on thrust chamber mating flange.

n. Temporarily remove safety cable attached to oxidizer turbopump support strut.

CAUTION

Care must be taken when positioning the thrust chamber injector over the engine not to damage the pressure-actuated seal.

o. Using hoist, place gimbal and thrust chamber injector into position over engine by passing it between oxidizer turbopump and main oxidizer valve, while working hoist toward track station 13.5 for engine positions 1 through 4, or track station 20 for engine position 5.

p. Reinstall safety cable to oxidizer turbopump support strut.

q. Install the 2 guide pins 180 degrees apart through thrust chamber injector bolt holes and pressure-actuated seal holes into thrust chamber.

CAUTION

Binding between the thrust chamber injector and thrust chamber during installation can cause damage to the thrust chamber injector and/or thrust chamber.

r. Using hoist, lower thrust chamber injector into place on thrust chamber.

s. Remove guide pins and handler.

t. Lubricate both sides of washers with Molykote Z powder (Dow Corning Corp); then install bolts and washers that secure thrust chamber injector to thrust chamber fingertight.

u. Raise engine by shortening turnbuckles until gimbal is about to engage stage. Keep engine reasonably level while raising by maintaining rotation of turnbuckles within one turn of each other.

v. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated by pushing on the engine about the dome area. If, however, there is gross misalinement, level engine and, or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustment mechanisms at top of turnbuckles. Adjust turnbuckles equally so that turnbuckles remain parallel to each other.

w. With gimbal alined, raise engine with 1-turn increments on turnbuckles until both keyways are engaged.

x. Continue raising engine by shortening turnbuckles until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage keep rotation of turnbuckles within one turn of each other.

y. Secure gimbal to stage using applicable stage procedures.

CAUTION

The thrust chamber can be damaged by striking the GSE or stage structure.

z. Cross-torque thrust chamber injector to thrust chamber bolts to 750 ±25 inch-pounds. Restrain engine while torquing bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, make sure bolts are seated, remove engine lowering system (step ab), and then torque bolts.

aa. Install bolts and washers, to secure customer connect tube support clevis to thrust chamber dome. Torque bolts to 750 ±25 inch-pounds.

ab. Remove engine lowering system. (Refer to section II.)

ac. Connect gimbal hydraulic actuators to engine attach points using applicable stage procedures.

ad. Disassemble track. (Refer to section II.)

ae. Install gimbal boot. Torque clamp bolts to 6-8 inch-pounds.

NOTE

Steps af through ah, outline start tank vent-and-relief valve installation.

af. Position valve and seal on tank flange and secure with bolts and washers. Torque bolts to 114-126 inch-pounds and safetywire. (See figure 3-12.)

ag. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 20-25 inch-pounds.

ah. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 inch-pounds.

ai. On engines not incorporating MD150 or MD192 change, weld augmented spark igniter pressure instrumentation tube.

aj. On engines not incorporating MD338 change, connect electrical connector P19 to ignition detector probe on injector dome. On engines incorporating MD330 change, connect electrical connector P165 to combustion temperature probe on injector dome.

ak. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, install augmented spark igniter fuel lines as follows:

(1) Install bolts and washers to secure fuel manifold to thrust chamber. Torque bolts to 62-68 inch-pounds and safetywire.

(2) Install seal, bolts, and washers to secure fuel probe line to augmented spark igniter fuel manifold. Torque bolts to 52-58 inch-pounds and safetywire.

al. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, install augmented spark igniter fuel line as follows:

(1) Install seal between augmented spark igniter fuel line and lower fuel line.

(2) Check alinement of mating holes in augmented spark igniter line flange with mating holes in lower fuel line flange. Holes must aline within ±0.125 inch.

(3) Measure gap between augmented spark igniter line and lower fuel line flange. Gap must be within 0.025 to 0.275 inch.

(4) Apply hand-pressure to augmented spark igniter line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(5) Apply hand-pressure to augmented spark igniter line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported, to prevent excessive loads on the weld near the augmented spark igniter injector when making alinement bends.

(6) If fuel line does not fall within tolerances of substeps 2 through 5, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support the fuel line to prevent movement during alinement

bending. Bends must not be made within 3 inches of any tube weld.

(7) Install seal, bolts, washers, and bracket on fuel line flange. Torque bolts to 40-55 inch-pounds.

am. Install temperature transducer and seal on spark igniter fuel manifold. Torque bolts to 48-53 inch-pounds and safetywire.

an. Connect electrical connector P131.

NOTE

To prevent corrosion, step ao through bf must be completed within 24 hours.

ao. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each igniter cable bell housing flange. Clean bonding surfaces of igniter cable bell housing and mating surfaces without damaging sealing surfaces.

ap. Lubricate bolts that attach augmented spark igniter cables to electrical control assembly with sealing compound.

aq. Lubricate augmented spark igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

ar. Install augmented spark igniter cables on electrical control assembly and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

as. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire. To minimize the need to disassemble due to augmented spark igniter cable leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

at. Install support clamps on augmented spark igniter cable pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 inch-pounds.

au. Connect electrical connectors P1, P2, and P3.

av. Lubricate bolts that attach gas generator spark igniter cables to electrical control assembly with sealing compound.

aw. Lubricate gas generator igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

ax. Install gas generator igniter cables on electrical control assembly with 2 bolts. Tighten bolts fingertight.

ay. Position bracket on igniter cable pressurizing tube bosses and secure bracket and igniter cable bell housing to electrical control assembly with bolts. Tighten bolts fingertight.

az. Install remaining bolts in igniter cable bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

ba. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire.

bb. Install washers and nuts on igniter cable pressurizing tube bosses and torque nuts to 150-200 inch-pounds and safetywire.

bc. Lubricate pressurizing valve O-ring seals for static service with FS1281 grease and install on valves.

bd. Install pressurizing valves in pressurizing tube bosses. Torque valves to 100-120 inch-pounds; after a minimum of 30 minutes, retorque to 100-120 inch-pounds and safetywire.

be. Measure inherent resistance from electrical control assembly to thrust chamber ground cable and from each igniter cable bell housing to thrust chamber. Resistance from each bell housing to thrust chamber must not exceed 100 milliohms above inherent resistance from electrical control assembly to thrust chamber ground cable.

bf. Apply a coating of blue-tinted lacquer to all bonding bolts and connections.

bg. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

NOTE

Steps bh through bg outline main oxidizer valve installation.

- The main oxidizer valve may be reinstalled or replaced without affecting engine calibration.

bh. Place main oxidizer valve and seal on oxidizer injector dome inlet flange and secure with bolts and washers. Using adapter, cross-torque bolts to 570-630 inch-pounds and safetywire.

bi. On engines incorporating MD180 or MD181 change, install seal and No. 2 mainstage OK pressure switch adapter on oxidizer dome inlet flange with bolts and washers. Torque bolts to 55-65 inch-pounds.

bj. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, install seal and connect augmented spark igniter oxidizer line to augmented spark igniter valve. Torque bolts to 41-45 inch-pounds.

bk. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, install augmented spark igniter oxidizer line as follows:

(1) Install seal between augmented spark igniter oxidizer line flange and augmented spark igniter valve.

(2) Check alinement of mating holes in flange of oxidizer line with mating holes in augmented spark igniter valve. Holes must aline within 0.250 inch.

(3) Measure gap between oxidizer line and mating flange of augmented spark igniter valve. Gap must not exceed 0.400 inch.

(4) Apply hand-pressure to oxidizer line until seal contacts mating surface of augmented spark igniter valve. Mating surfaces of oxidizer line flange and valve flange must be parallel within 0.080 inch.

(5) Apply hand-pressure to oxidizer line until seal contacts mating surface of valve. If bolts can be installed without force, rotational alinement is acceptable.

(6) Check line deflection between oxidizer line and cutout in block clamps. Deflection must not exceed 0.063 inch in either direction from lowest point of block clamp cutout when installed on brackets. (A maximum of 4 shims may be used between brackets and block clamps to obtain alinement.)

CAUTION

The oxidizer line must be supported, to prevent excessive loads on the weld near the augmented spark igniter injector when making alinement bends.

(7) If oxidizer line does not fall within tolerances outlined in substeps 2 through 6, bend oxidizer line to meet requirements. Use an approved tube-bending tool, and support the oxidizer line, to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

(8) Install seal, bolts, washers, and bracket on oxidizer line flange. Torque bolts to 40-55 inch-pounds.

bl. Install seal and connect augmented spark igniter oxidizer line to augmented spark igniter valve. Torque bolts to 41-45 inch-pounds.

bm. Weld gas generator pressure equalization line. (See figure 3-24.)

bn. Install seals, bolts, and washers securing flanges to the following ports on the main oxidizer valve: pre-stage inlet, sequence control valve inlet, sequence control valve outlet, opening port and closing port. Install orifice in opening control port with cupped side of orifice toward main oxidizer valve. Torque bolts to 41-45 inch-pounds and safetywire.

bo. Connect electrical connectors P115 and P120.

bp. Install oxidizer high-pressure duct (paragraph 3-68).

bq. Weld purge inlet line, purge outlet line, control line, overboard vent line, and sequence control valve outlet line. (See figure 3-23.)

br. Install fuel inlet duct (paragraph 3-20) and oxidizer inlet duct (paragraph 3-62) for engine positions 1 through 4; install ducts in accordance with applicable stage procedures for engine position 5.

bs. Connect electrical and fluid interface lines in accordance with applicable stage procedures, and remove electrical and fluid interface supports.

bt. Refer to R-3825-3 for post-maintenance test.

3-87. REMOVING THRUST CHAMBER INJECTOR (SIVB STAGE).

a. Assemble track for thrust chamber injector removal, as required for applicable stage. (Refer to section II.) Install turntable with controls trailing.

b. Obtain the following equipment:

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2

(2) Engine component handler 9024539 from Engine Components Installer G4072, shelf 3

(3) Engine component pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Engine component hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Chain-hoist 9027095 from engine components installer set 9026252

(6) Component handling cart 9026253 from engine components installer set 9026252

(7) Extension bar SX-24 from engine components installer set 9026252

(8) Universal joint S8 from engine components installer set 9026252

(9) Single Head Special Tool Kit G3127

(10) Fluid level, 4-6 inches long

(11) Adapter T-5044412

(12) Shackle, G-209-9-1 2 or G-210-9-1 2 (Crosby-Laughlin, Inc)

(13) Guide pins, (two required) (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(14) Torque wrench capable of torquing to 145-185 inch-pounds

(15) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical arm)

(16) Electrical interface support 9024460

(17) Fluid interface support 9020628

c. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Installing closures

(2) Disconnecting electrical connectors

(3) Cutting tubes

(4) Torquing

d. Obtain closures, or suitable equivalent, for main oxidizer valve, start tank vent-and-relief valve, augmented spark igniter valve, augmented spark igniter and gimbal. (Refer to R-3825-4 for closures.) Closures must be certified clean for use in a propellant system.

e. Remove fuel inlet duct (paragraph 3-21) and oxidizer inlet duct (paragraph 3-63).

f. Remove oxidizer high-pressure duct (paragraph 3-69).

NOTE

Steps g through k outline purge control valve removal.

- The purge control valve may be replaced without affecting engine calibration.

g. Cut purge inlet line.

h. Cut control line, purge outlet line, overboard vent line, and main oxidizer valve sequence control valve outlet line, below flange joint of oxidizer dome and thrust chamber. (See figure 3-23.)

i. Remove screws, washers, and nuts that secure igniter cable and clamps to purge control valve. (See figure 3-23.)

j. Remove bolt, washer, nut, and clamp that re control line.

k. Remove purge control valve and support bracket from engine.

l. Install closures on all open ports.

m. Disconnect electrical connectors P115 and P120. (See figure 3-24.)

n. Remove bolts and washers that secure augmented spark igniter oxidizer line to augmented spark igniter valve. (See figure 3-24.)

o. Remove bolts and washers that secure flanges to the following ports on the main oxidizer valve: pre-stage inlet, sequence control valve inlet, sequence control valve outlet, opening control port, and closing control port. Retain orifice removed from opening control port, for reinstallation.

p. Cut gas generator pressure equalization line.

q. Disconnect electrical connectors P20 and P26 and pressure lines from mainstage OK sure switches. On engines incorporating MD180 or MD181 change, remove bolts and washers that secure mainstage OK pressure switch adapter plate to oxidizer dome inlet. Remove seal.

r. Using adapter, remove bolts and washers that secure main oxidizer valve to oxidizer dome inlet.

s. Remove main oxidizer valve and seal.

t. Install closures on oxidizer valve and all open ports.

u. Measure pressure in igniter cables as outlined in R-3825-1B; then depressurize igniter cables by backing off pressurizing valve locknut (see figure 3-3) 1-3 turns and depressing valve core.

WARNING

Applying electrical power to the engine when connecting or disconnecting electrical connectors and/or igniter cables or when igniter cables are disconnected can cause electrical arcing, resulting in injury to personnel and damage to equipment.

v. Make sure all electrical power to engine is turned off.

w. Remove the 4 pressurizing valves, nuts, and washers from pressurizing bosses, and install closures on all open ports.

x. Remove bolts that secure pressurizing valve mounting bracket to bell housing of gas generator igniter cables and remove bracket.

CAUTION

Care must be taken throughout the following procedures, or damage to the igniter cable pressurizing tubes can result.

y. Remove remaining bolts that attach gas generator igniter cables to electrical control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on the cable bell housing can damage the igniter cable and electrical control assembly.

z. Remove gas generator igniter cable bell housing from electrical control assembly, pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step aa immediately.

aa. Install support ST3950166RKL001 and closures on igniter NA5-27448 as follows: (Install closures only on all other igniter cables and exciters.)

(1) Inspect interior of bell housing to make sure sealing grommet is on Teflon connector, keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbored holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

ab. Install closures on igniter cables 651389 and 651390 and on exciters.

ac. Temporarily secure cables to engine.

ad. Disconnect electrical connectors P1, P2, and P3.

ae. Remove nut, washers, and screws from augmented spark igniter cable pressurizing tube support clamps.

af. Remove bolts that secure augmented spark igniter cables to control assembly.

CAUTION

Tipping or side motion of the igniter cable bell housing before the cable plug is clear of the exciter output adapter can break or distort the adapter fingers.

- Pulling on the igniter cable or prying on the cable bell housing can damage the igniter cable and electrical control assembly.

ag. Remove augmented spark igniter cable bell housing from electrical control assembly. pulling straight out until cable plug clears exciter output adapter. Use care to prevent damage to igniter cable and electrical control assembly. Accomplish step ah immediately.

ah. Install support ST3950166RKL001 and closure on igniter cable NA5-27448 as follows: (Install closures only on all other igniter cables and on exciters.)

(1) Inspect interior of bell housing to make sure sealing grommet is on Teflon connector. keeping cable movement to a minimum.

(2) Install support ST3950166RKL001 on igniter cable bell housing, making sure plastic plunger in support is seated in igniter cable terminal tip. Install bolts and washers in counterbore holes in support.

(3) Tighten bolts until flange on support seats on igniter cable bell housing flange.

(4) Install closure over support.

ai. Remove igniter cable support clamps. Note position of clamps for reinstallation.

aj. On engines not incorporating MD338 change, disconnect electrical connector P19 from ignition detector probe on injector dome. On engines incorporating MD330 change, disconnect electrical connector P165 from combustion temperature probe on injector dome.

ak. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, cut safetywire and remove bolts and washers that secure fuel probe line to augmented spark igniter fuel manifold and to thrust chamber. (See figure 3-25.) Remove seal. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, cut safetywire and remove bolts and washers that secure augmented spark igniter fuel line to lower fuel line flange. Remove seal.

al. Disconnect electrical connector P131 from temperature transducer on spark igniter fuel manifold. Remove transducer and install closure.

am. On engines not incorporating MD150 or MD192 change, cut augmented spark igniter pressure instrumentation tube.

NOTE

On engines incorporating MD150 change, the augmented spark igniter pressure instrumentation tube is capped; on engines incorporating MD192 change, the tube is removed.

an. Install closures on all open ports.

WARNING

Removing start tank components before the system is depressurized can result in serious injury to personnel and damage to equipment.

- Removing components from a system containing gaseous hydrogen can cause an explosion, resulting in serious injury or death to personnel and damage to equipment.

ao. Prior to removing start tank vent-and-relief valve, make sure system is depressurized and has been purged in accordance with purge

rocedures in R-3825-3, since the last time el was introduced into system.

NOTE

Steps ap through ar outline start tank vent-and-relief valve removal.

ap. Remove bolts, washers, and nuts that secure vent line bracket to support. (See figure 3-12.)

aq. Remove screw, washer, and nut that secure control line clamp to bracket.

ar. Remove bolts and washers that secure start tank vent-and-relief valve to integral hydrogen-helium start tank. Remove seal.

as. Install closures on all open ports.

at. Temporarily reposition and secure start tank vent-and-relief valve, to provide vertical access for removal of thrust chamber injector.

au. Install electrical and fluid lines interface supports on engine. Disconnect electri- l and fluid interface lines from stage, and ach disconnected lines to interface supports.

av. Remove gimbal boot.

aw. Install engine lowering system. (Refer to section II.) Engine must be lowered a maximum of 7 inches to remove injector.

ax. Adjust lower end of both turnbuckles to dimension shown in figure 3-26.

ay. Make sure that engine is level in plane controlled by turnbuckles and that turnbuckles are manually tightened (no slack). Use fluid level on oxidizer dome or dome bolts, to check level of engine.

az. Remove bolts and washers that secure customer-connect tube support clevis to thrust chamber dome.

ba. Loosen bolts that secure thrust chamber injector to thrust chamber one turn.

CAUTION

While the weight of the engine is supported by the turnbuckles, the adjustments at the lower end of the turnbuckles must not be changed. Changing the lower-end adjustment can induce moments into the turnbuckles that can bend and may break the turnbuckles.

bb. Make sure lower end of turnbuckles are positioned to dimension shown in figure 3-26; then loosen hardware that secures gimbal to stage, and back off nuts 1/2 ±1 16 inch.

bc. Slowly lower engine by extending turnbuckles until a 1/4 ±1/16 inch gap exists between stage and gimbal. Rotate turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other.

bd. Adjust mechanism at top of turnbuckles to position turnbuckles vertically in 2 planes, 90 degrees apart. Use fluid level.

be. Remove nuts and bolts that formerly secured gimbal to stage.

NOTE

There will be some small side movement at the gimbal, the effect of which can be minimized by lowering the engine slowly and carefully.

bf. Slowly lower engine by rotating turnbuckles simultaneously, maintaining rotation of turnbuckles within one turn of each other until just prior to disengagement of gimbal keyway, at which time, reduce rotation of turnbuckles to 1/6-turn increments until gimbal is clear. Monitor the gimbal while lowering, for evidence of binding or cocking. Correct binding or cocking by straightening gimbal by hand or by pushing on engine around dome area.

NOTE

One flat of turnbuckles adjusting barrel may be marked as an index to keep count of turnbuckle rotations.

bg. Lower engine a maximum of 7 inches by extending turnbuckles. While lowering, keep engine reasonably level by maintaining turnbuckles within one turn of each other.

bh. Attach handler to hoist and extend adapter to 6th positioning hole. Secure with ball-lock pin. Yoke of handler is to be horizontal with side of yoke that contains sliding plate up.

bi. Manipulate hoist and straddle gimbal with adapter as shown in figure 3-10. Handler position is to be over engine, between oxidizer inlet flange and oxidizer turbopump.

bj. Loosen knobs that secure 4 tubes of handler, and adjust tubes until they contact dome (with handler in approximately level position); then tighten knobs fingertight.

bk. Remove bolts and washers that secure thrust chamber injector to thrust chamber.

bl. Install guide pins in thrust chamber-to-injector boltholes adjacent to the lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and add unnecessary loads to the hoisting equipment.

bm. Using hoist, lift thrust chamber injector from thrust chamber. Keep lift vertical by coordinating lateral and/or longitudinal adjustment of turntable controls with hoist boom vertical controls.

bn. After thrust chamber injector is clear of thrust chamber, remove guide pins.

bo. Temporarily remove safety cable attached to oxidizer turbopump support strut.

bp. Using hoist, move thrust chamber injector clear of engine.

bq. Reinstall safety cable to oxidizer turbopump support strut.

br. Install closures on all open ports.

bs. Assemble hanger and place hanger in area that will be accessible to both lower and elevated track. (See appropriate track configuration figure in section II.)

bt. Using hoist, move turbopump to hanger.

bu. Install engine component handler 9024539 on gimbal. Torque bolts to 145-185 inch-pounds.

bv. Install pickup adapter on hanger and secure with ball-lock pin.

bw. Raise thrust chamber injector until engine component handler engages pickup adapter. Secure with ball-lock pin.

bx. Remove hoist and handler 9027263 from thrust chamber injector.

by. Assemble elevated track. (Refer to section II.)

bz. Install chain-hoist on hoist and secure with ball-lock pin.

ca. Install shackle on pickup adapter. Do not install shackle in pickup adapter slot.

cb. Move hoist into position to pick up thrust chamber injector.

cc. Connect chain-hoist chain to shackle.

cd. Using hoist and chain-hoist, remove thrust chamber injector from hanger.

CAUTION

The thrust chamber injector must be restrained due to the limited access, to prevent damage to the thrust chamber injector and stage.

ce. Using hoist, move thrust chamber injector through stage access door. Manually restrain movement of thrust chamber injector when moving it through stage access door.

cf. Place a clean sheet of polyethylene on floor of component handling cart and using chain-hoist and hoist, lower thrust chamber injector into cart.

cg. Remove ball-lock pin that secures pickup adapter to engine component handler. Remove engine component handler from gimbal.

3-88. INSTALLING THRUST CHAMBER INJECTOR (SIVB STAGE).

a. Obtain the following equipment and materials:

(1) Gimbal and injector handler 9027263 from Engine Components Installer G4072, shelf 2

(2) Engine component handler 9024539 from Engine Components Installer G4072, shelf 3

(3) Engine component pickup adapter 9024547 from Engine Components Installer G4072, shelf 3

(4) Engine component hanger 9024543 from Engine Components Installer G4072, shelf 2

(5) Chain-hoist 9027095 from engine components installer set 9026252

(6) Component handling cart 9026253 from engine components installer set 9026252

(7) Universal joint S8 from engine components installer set 9026252

(8) Extension bar SX-24 from engine components installer set 9026252

(9) Automatic Inert Gas Arc Welding Set G3128

(10) Single Head Special Tool Kit G3127

(11) Fluid level, 4-6 inches long

(12) Torque wrench capable of torquing to 6-126 inch-pounds

(13) Torque wrench capable of torquing to 145-630 inch-pounds

(14) Torque wrench capable of torquing to 725-775 inch-pounds

(15) Adapter T-5044412

(16) Shackle G-209-9-1/2 or G-210-9-1 2 (Crosby-Laughlin, Inc), or equivalent.

(17) Blue-tinted lacquer ST0125RB0003 (Rocketdyne) (Mixture contains 1-3 parts, by weight, of blue dye to 1,000 parts of lacquer.)

(18) Sealing compound RB0140-005 (Rocketdyne)

(19) Abrasive cloth, 320-grit or finer

(20) FS1281 grease (Dow Corning Corp)

(21) Ramp 9026255 from engine components installer set 9026252 (three required for use on launch tower umbilical tower)

(22) Guide pins (two required) (Make from RD111-4009-6860 or RD111-4009-6862 bolts, or equivalent.)

(23) Molykote Z powder (Dow Corning Corp)

b. When accomplishing the following tasks, refer to R-3825-3 for specific requirements:

(1) Connecting electrical connectors

(2) Welding tubes

(3) Torquing

(4) Safetywiring

(5) Removing closures

c. Install handler 9024539 on gimbal. Torque bolts to 145-185 inch-pounds.

d. Install pickup adapter on handler 9024539. Secure with ball-lock pin.

e. Install shackle on pickup adapter. Do not install shackle in pickup adapter slot.

f. Install chain-hoist on hoist and secure with ball-lock pin.

g. Attach chain-hoist chain to shackle.

h. Using hoist and chain-hoist, raise thrust chamber injector from cart.

CAUTION

The thrust chamber injector must be restrained due to the limited access, to prevent damage to the thrust chamber injector and stage.

i. Using hoist, move thrust chamber injector into stage and to hanger. Manually restrain

movement of thrust chamber injector when moving it through stage access door.

j. Lower injector to hanger and engage pickup adapter to hanger. Secure with ball-lock pin.

k. Disconnect chain from shackle, and remove chain-hoist from hoist, and shackle from pickup adapter.

l. Disassemble elevated track, and reassemble lower track. (Refer to section II.)

m. Attach gimbal and injector handler to hoist and extend handler adapter to 6th positioning hole. Secure with ball-lock pin.

n. Using hoist, install gimbal and injector handler on gimbal. (See figure 3-10.) Handler is to be positioned to extend over engine between oxidizer inlet flange and augmented spark igniter oxidizer propellant line.

o. Using hoist, raise thrust chamber injector. Remove ball-lock pin that attaches pickup adapter to handler 9024539.

p. Remove handler 9024539 from gimbal.

q. Using hoist, move thrust chamber injector to engine position. Position hoist at track station.

r. Remove safety cable attached at oxidizer turbopump strut (figure 2-47) to allow thrust chamber injector to be moved into position.

s. Using hoist, move thrust chamber injector into position above thrust chamber by passing it over engine between oxidizer turbopump and main oxidizer valve.

t. Install safety cable removed in step r.

u. Remove closures, as required during installation, to make connections.

v. Install guide pins in thrust chamber-to-injector boltholes adjacent to lowering system attach points.

CAUTION

Binding between the injector and thrust chamber can cause damage to the thrust chamber and/or injector and all unnecessary loads to hoist equipment.

w. Install seals and lower thrust chamber injector onto thrust chamber. While lowering, keep thrust chamber injector centered on vertical axis of thrust chamber, to prevent binding between injector and thrust chamber.

x. Remove guide pins. Lubricate both sides of washers with Molykote Z powder (Dow Corning Corp; then install bolts and washers that secure thrust chamber injector to thrust chamber fingertight.

y. Remove handler from thrust chamber injector and gimbal.

z. Raise engine by shortening turnbuckles, until gimbal is about to engage stage. Keep engine reasonably level while raising by maintaining rotation of turnbuckles within one turn of each other.

aa. Check that gimbal alines with stage. If there exists some small misalinement in the x- and z-axes, it can be compensated by pushing on the engine about the dome area. If, however, there is gross misalinement, level engine and/or aline gimbal to stage by one or more of the following methods:

(1) Level engine by adjusting length of turnbuckles.

(2) If engine is level and gimbal does not aline, move engine in direction to aline gimbal to stage by use of adjustment mechanisms at top of turnbuckles. Adjust turnbuckles equally so that turnbuckles remain parallel to each other.

ab. With gimbal alined, raise engine with 1/6-turn increments on turnbuckles until both keyways are engaged.

ac. Continue raising engine by shortening turnbuckles until gimbal is fully engaged (less than 0.030-inch gap) with stage. To aid in prevention of binding between gimbal and stage, keep rotation of turnbuckles within one turn of each other.

ad. Secure gimbal to stage using applicable stage procedure.

CAUTION

The thrust chamber can be damaged by striking GSE or stage structure.

ae. Cross-torque bolts that secure thrust chamber injector to thrust chamber to 750 ±25 inch-pounds. Restrain engine while tightening bolts, to prevent engine from gimbaling and striking GSE or surrounding stage structure. If torquing cannot be accomplished because of interference with engine lowering system, make sure bolts are seated, remove engine lowering system (step ag), and then torque bolts.

af. Install bolts and washers to secure customer-connect tube support clevis to thrust chamber dome. Torque bolts to 750 ±25 inch-pounds.

ag. Remove engine lowering system. (Refer to section II.)

ah. Connect gimbal hydraulic actuators to airframe attach points using applicable stage procedures.

ai. Connect fluid interface lines using applicable stage procedures.

aj. Remove electrical and fluid interface line supports.

ak. Disassemble track. (Refer to section II.)

al. Install gimbal boot. Torque clamp bolts to 6-8 inch-pounds.

NOTE

Steps am through ao outline start tank vent-and-relief valve installation.

am. Position valve and seal on tank flange and secure with bolts and washers. Torque bolts to 114-126 inch-pounds and safetywire. (See figure 3-12.)

an. Install bolts, washers, and nuts securing vent line bracket to support. Torque bolts to 25 inch-pounds.

ao. Install screw, washer, and nut securing control line clamp to bracket. Torque screw to 6-8 inch-pounds.

ap. On engines not incorporating MD150 or MD192 change, weld augmented spark igniter pressure instrumentation tube.

aq. On engines not incorporating MD338 change, connect electrical connector P19 to igniter detector probe on injector dome. On engines incorporating MD330 change, connect electrical connector P165 to combustion temperature probe on injector dome.

ar. On engines not incorporating MD327, MD328, MD329, MD332 or MD344 change, install augmented spark igniter fuel lines as follows:

(1) Install bolts and washers to secure fuel manifold to thrust chamber. Torque bolts to 62-68 inch-pounds and safetywire.

(2) Install seal, bolts, and washers to secure fuel probe line to augmented spark igniter fuel manifold. Torque bolts to 52-58 inch-pounds and safetywire.

as. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, install augmented spark igniter fuel line as follows:

(1) Install seal between augmented spark igniter fuel line and lower fuel line.

(2) Check alinement of mating holes in augmented spark igniter line flange with mating holes in lower fuel line flange. Holes must aline within ±0.125 inch.

(3) Measure gap between augmented spark igniter line and lower fuel line flange. Gap must be within 0.025 to 0.027 inch.

(4) Apply hand-pressure to augmented spark igniter line flange until seal contacts mating surface of lower fuel line flange. Mating surfaces must be parallel within 0.025 inch.

(5) Apply hand-pressure to augmented spark igniter line flange until seal contacts mating surface of lower fuel line flange. If all bolts can be installed without forcing, rotational alinement is acceptable.

CAUTION

The fuel line must be supported, to prevent excessive loads on the weld near the augmented spark igniter injector when making alinement bends.

(6) If fuel line does not fall within tolerances of substeps 2 through 5, bend fuel line to meet alinement requirements. Use an approved tube-bending tool, and support the fuel line to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

(7) Install seal, bolts, washers, and bracket on fuel line flange. Torque bolts to 40-55 inch-pounds.

at. Install temperature transducer and seal on spark igniter fuel manifold. Torque bolts to 48-53 inch-pounds and safetywire.

au. Connect electrical connector P131.

NOTE

To prevent corrosion, steps av through bm must be completed within 24 hours.

av. Using abrasive cloth, remove protective finishes and foreign matter from 4 attaching bolts and area around 4 mating holes, 90 degrees apart, on each igniter cable bell housing flange. Clean bonding surfaces of igniter cable bell housing and mating surfaces without damaging sealing surfaces.

aw. Lubricate bolts that attach augmented spark igniter cables to electrical control assembly with sealing compound.

ax. Lubricate augmented spark igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

ay. Install augmented spark igniter cables on electrical control assembly and secure with bolts. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

az. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire. To minimize the need to disassemble due to augmented spark igniter cable leakage, an interim leak test of these cables may be made at this time. (Refer to R-3825-1B for test procedures.)

ba. Install support clamps on augmented spark igniter cable pressurizing tubes with bolts, washers, and nuts. Torque nuts to 33-42 inch-pounds.

bb. Connect electrical connectors P1, P2, and P3.

bc. Lubricate bolts that attach gas generator spark igniter cables to electrical control assembly with sealing compound.

bd. Lubricate gas generator igniter cable O-ring seals for static service with sealing compound and install in O-ring groove.

be. Install gas generator igniter cables on electrical control assembly with 2 bolts. Tighten bolts fingertight.

bf. Position bracket on igniter cable pressurizing tube bosses and secure bracket and igniter cable bell housing to electrical control assembly with bolts. Tighten bolts fingertight.

bg. Install remaining bolts in igniter cable bell housing. Install bolts cleaned for bonding in holes with surrounding area cleaned for bonding. Tighten bolts fingertight.

bh. Cross-torque bolts that secure igniter cables to electrical control assembly in the following sequence: 15, 25, and 35 inch-pounds. Repeat cross-torque to 35 inch-pounds and safetywire.

bi. Install washers and nuts on igniter cable pressurizing tube bosses and torque nuts to 150-200 inch-pounds and safetywire.

bj. Lubricate pressurizing valve O-ring seals for static service with FS1281 grease and install on valves.

bk. Install pressurizing valves in pressurizing tube bosses. Torque valves to 100-120 inch-pounds; after a minimum of 30 minutes, retorque to 100-120 inch-pounds and safetywire.

bl. Measure inherent resistance from electrical control assembly to thrust chamber ground cable and from each igniter cable bell

housing to thrust chamber. Resistance from bell housing to thrust chamber must not exceed 100 milliohms above inherent resistance from electrical control assembly to thrust chamber ground cable.

bm. Apply a coating of blue-tinted lacquer to all bonding bolts and connections.

bn. Leak-test and pressurize igniter cables. (Refer to R-3825-1B.)

NOTE

Steps bo through bw outline main oxidizer valve installation.

- The main oxidizer valve may be reinstalled or replaced without affecting engine calibration.

bo. Place main oxidizer valve and seal on oxidizer injector dome inlet flange and secure with bolts and washers. Using adapter, cross-torque bolts to 570-630 inch-pounds and safety-wire.

bp. On engines incorporating MD180 or MD181 change, install seal and No. 2 mainstage OK pressure switch adapter on oxidizer dome inlet flange with bolts and washers. Torque bolts to 55-65 inch-pounds.

. On engines not incorporating MD327, MD328, MD329, MD332, or MD344 change, install seal and connect augmented spark igniter oxidizer line to augmented spark igniter valve. Torque bolts to 41-45 inch-pounds.

br. On engines incorporating MD327, MD328, MD329, MD332, or MD344 change, install augmented spark igniter oxidizer line as follows:

(1) Install seal between augmented spark igniter oxidizer line flange and augmented spark igniter valve.

(2) Check alinement of mating holes in flange of oxidizer line with mating holes in augmented spark igniter valve. Holes must aline within 0.250 inch.

(3) Measure gap between oxidizer line and mating flange of augmented spark igniter valve. Gap must not exceed 0.400 inch.

(4) Apply hand-pressure to oxidizer line until seal contacts mating surface of augmented spark igniter valve. Mating surfaces of oxidizer line flange and valve flange must be parallel within 0.080 inch.

(5) Apply hand-pressure to oxidizer line seal contacts mating surface of valve. If bolts can be installed without force, rotational alinement is acceptable.

(6) Check line deflection between oxidizer line and cutout in block clamps. Deflection must not exceed 0.063 inch in either direction from lowest point of block clamp cutout when installed on brackets. (A maximum of 4 shims may be used between brackets and block clamps to obtain alinement.)

CAUTION

The oxidizer line must be supported to prevent excessive loads on the weld near the augmented spark igniter injector when making alinement bends.

(7) If oxidizer line does not fall within tolerances outlined in substeps 2 through 6, bend oxidizer line to meet requirements. Use an approved tube-bending tool, and support the oxidizer line, to prevent movement during alinement bending. Bends must not be made within 3 inches of any tube weld.

(8) Install seal, bolts, washers, and bracket on oxidizer line flange. Torque bolts to 40-55 inch-pounds.

bs. Weld gas generator pressure equalization line. (See figure 3-24.)

bt. Install seals, bolts, and washers securing flanges to the following ports on the main oxidizer valve: pre-stage inlet, sequence control valve inlet, sequence control valve outlet, opening port and closing port. Install orifice in opening control port with cupped side of orifice toward main oxidizer valve. Torque bolts to 41-45 inch-pounds and safetywire.

bu. Connect electrical connectors P115 and P120.

bv. Install oxidizer high-pressure duct (paragraph 3-70).

bw. Weld purge inlet line, purge outlet line, control line, overboard vent line, and sequence control valve outlet line. (See figure 3-23.)

bx. Install fuel inlet duct (paragraph 3-22) and oxidizer inlet duct (paragraph 3-64).

by. Refer to R-3825-3 for post-maintenance test.

SECTION IV

MAINTENANCE

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4-1. SCOPE. This section provides procedures for maintenance of Engine Components Installers G4071 and G4072 and engine components installer sets 9026251 and 9026252. Figure 4-1 lists the maintenance requirements, identifies to which components installer or installer set the requirements apply, lists the required tasks, indicates when the task is to be performed, and either supplies the necessary data or makes a reference to where the data to perform the task can be found.

4-2. CLEANING NONMETALLIC COMPONENTS AND NONMETALLIC BONDED COMPONENTS.

4-3. Hand-wipe components containing packings, gaskets, seals, and nonmetallic bonded material with a clean, lint-free cloth moistened with a solution containing 4-6 ounces (5-7 ounces if extremely contaminated) of mild alkaline cleaner RB0210-005 (Rocketdyne) for each gallon of water, heated to 150° ±10° F. Rinse component with clear water until all traces of alkaline solution are removed, and dry with low-pressure gaseous nitrogen (MIL-P-27401).

4-4. CLEANING METALLIC COMPONENTS.

WARNING

The following procedure uses trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapor or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

4-5. Clean metallic components by vapor degreasing (preferred) or by hand-wiping surfaces with trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302) and dry with low-pressure gaseous nitrogen (MIL-P-27401).

4-6. LUBRICATING BALL-LOCK PINS.

4-7. Lubricating ball-lock pins consists of removing existing lubricant, cleaning, and lubricating.

WARNING

The following procedure uses trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapor or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

G4071	9026251	G4072	9026252	Requirements	Receiving	Prior to Use	Storage	Special	Reference Remarks
				Inspect engine components installers and installer sets for:					
				Completeness	X	X			Refer to section I.
				Damaged or removed paint	X		X	X	After use and prior to storage, repaint to original color. Use gloss enamel (MIL-E-7729, Type I), color No. 13538 (yellow) or color No. 11136 (red), as applicable.
				Obliterated identification markings	X			X	Stencil markings using cellulose lacquer (Federal Specification TT-L-32), color numbers 11136 (gloss red) or 17038 (gloss black), and camouflage lacquer (Federal Specification TT-L-20), color No. 37038 (flat black), as applicable.
				Frayed, broken, or missing cables		X			Replace cables.
				Inoperative or missing ball-lock pins		X			Lubricate inoperative ball-lock pins (Refer to paragraph 4-6.)
				Damaged or missing straps, buckles, or attaching hardware	X	X			Replace hardware.
X		X		Inspect stowage cart for:					
				Damaged compartment doors, hinges, or locks	X	X			Replace hardware.
				Damaged or missing handles, straps, component supports, or braces on shelves	X	X			Replace parts.
				Inoperative brakes	X	X			Adjust brakes. (Refer to paragraph 4-12.)
				Binding swivel locks	X	X			Repair parts.
				Cracked frames		X			Weld or replace.
				Damaged tow bar		X			Replace.
				Lifting and tiedown rings for security		X			Screw fully into boss.

Figure 4-1. Maintenance Requirements for Engine Components Installers and Installer Sets (Sheet 1 of 6)

G4071	9026251	G4072	9026252	Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
X		X		Inspect cover for tears, opened seams, damaged or missing tiedown straps		X			Repair or replace cover.
X		X		Inspect turntable for:					
				Binding controls		X			Lubricate. (Refer to paragraph 4-20.)
				Foreign matter on chain-drive mechanism and gears		X			Clean. (Refer to paragraph 4-5.)
				Worn or damaged wheels, sprockets, bushings, or pins		X			Replace parts.
				Clearance of wheels to tracks				X	Adjust clearance every time a wheel is replaced. (Refer to paragraph 4-22.)
X		X		Inspect boom for:					
				Foreign matter on drive-screw or sliding surfaces		X			Clean. (Refer to paragraph 4-4.)
				Damaged threaded parts		X			Replace parts.
				Cracks		X			Weld or replace.
				Binding controls		X			Lubricate. (Refer to paragraph 4-20.)
				Inspect handlers, adapters, and slings for:					
X	X	X	X	Cracks		X			Weld or replace frames.
X	X	X	X	Worn or frayed straps or slings		X			Replace.
X		X		Loose or missing Teflon gaskets		X			Cement new or loose Teflon gaskets. (Refer to paragraph 4-10.)

Figure 4-1. Maintenance Requirements for Engine Components Installers and Installer Sets (Sheet 2 of 6)

G4071	9026251	G4072	9026252	Requirements	Receiving	Prior to Use	Storage	Special	Reference Remarks
X	X	X	X	Inspect track sections and track stops for:					
				Burs, rough edges, or evidence of galling on rails and plug exterior surfaces		X			Repair surface. (Refer to paragraph 4-16.)
				Burs, rough edges, or evidence of galling on rails and adapter interior surfaces		X			Repair surface. (Refer to paragraph 4-16.)
				Loose or missing rubber pads		X			Repair or replace. (Refer to paragraph 4-8.)
X	X	X	X	Inspect track bases, platforms, supports, and beams for:					
				Cracks		X			Weld or replace.
				Galled or missing threaded parts		X			Replace parts.
				Damaged or missing attaching hardware		X			Replace parts.
				Loose or missing rubber pads	X	X			Repair or replace. (Refer to paragraph 4-8.)
X	X	X	X	Inspect extensions for binding or galled threads.		X			Replace if threads galled. Lubricate with Molykote G paste (Dow Corning Corp), or equivalent, if binding.
X	X		X	Inspect struts for:					
				Galled or binding threads		X			Replace if threads galled. Lubricate with Molykote G paste (Dow Corning Corp), or equivalent, if binding.
				Security of ball-lock pins		X			Replace parts.
				Inspect support and track pins for:					
X		X	X	Galled or damaged threads on support pins		X			Replace pins.
X		X		Security of ball-locks on track pins		X			Replace pins.
X		X	X	Burs, sharp edges, or raised material		X			Replace pins.

Figure 4-1. Maintenance Requirements for Engine Components Installers and Installer Sets (Sheet 3 of 6)

G4071	9026251	G4072	9026252	Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
X		X		Inspect brackets for:					
				Loose or missing rubber pads	X	X			Repair or replace pads. (Refer to paragraph 4-8.)
				Damaged or missing attaching hardware		X			Replace parts.
X		X		Inspect internal access platform and base for:					WARNING The following procedure uses toluene and methyl-ethyl-ketone, which are flammable and must not be used near heat or open flame. Inhalation of their vapors or prolonged contact with the liquid can cause serious injury (methyl-ethyl-ketone) or death (toluene).
				Damaged or missing protective coating		X			Repair or replace protective coating. Clean metal surfaces for bonding by wiping with a clean nylon cloth No. 7815 (Victor Gloves, Inc), or equivalent, moistened with toluene (Federal Specification TT-T-548) or methyl-ethyl-ketone (Federal Specification TT-M-261). Coat surface with Microsol spray S-2003 (Michigan Chrome and Chemical Co), 0.015- to 0.040-inch thick.
				Loose rubber on edge of plywood platform		X			Cement rubber pads. (Refer to paragraph 4-8.)
				Loose rubber protector on support frame		X			Cement rubber protector. (Refer to paragraph 4-8.)
X		X		Inspect engine lowering system for:					
				Damaged threaded parts		X			Replace parts.
				Cracks		X			Weld or replace.
	X		X	Inspect hoist for:					
				Damaged safety hook or chain		X			Replace hardware.
				Foreign matter on chain		X			Clean. (Refer to paragraph 4-4.)

Figure 4-1. Maintenance Requirements for Engine Components Installers and Installer Sets (Sheet 4 of 6)

G4071	9026251	G4072	9026252	Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
	X		X	Inspect cable sling for:					
				Damaged safety hooks		X			Replace hardware.
				Kinked or frayed cables		X			Replace cables.
	X		X	Inspect ramps for:					
				Cracks		X			Weld or replace.
				Broken or frayed straps		X			Replace straps.
	X	X		Inspect hanger for:					
				Cracks		X			Weld or replace.
				Loose or missing pads		X			Repair or replace. (Refer to paragraph 4-8.)
	X		X	Inspect winch-hoists for:					
				Kinked or frayed cable		X			Replace cables.
				Damaged safety hooks		X			Replace hardware.
	X		X	Inspect cart for:					
				Inoperative brakes	X	X			Adjust brakes. (Refer to paragraph 4-12.)
				Security of lifting and tie-down rings		X			Screw fully into boss.
				Loose or missing rubber pads or guards	X	X			Repair or replace. (Refer to para-4-8.)
				Lubricate:					
X	X	X	X	Ball-lock pins				X	Every 12 months. (Refer to paragraph 4-6.)
X		X		Hoist:					
				Drivescrew (vertical travel)		X			Lubricate with fluorolube grease GR362 (Hooker Chemical Corp).
				Sliding surfaces				X	Every 12 months. (Refer to paragraph 4-20.)

Figure 4-1. Maintenance Requirements for Engine Components Installers and Installer Sets (Sheet 5 of 6)

9026252	Requirements	Receiving	Prior to Use	Storage	Special	Reference/Remarks
	Wheel frame rotation bearings				X	Every 12 months. (Refer to paragraph 4-24.)
	Turntable support bearing				X	Every 12 months. (Refer to paragraph 4-26.)
X	Lift jack wheels				X	Every 6 months. Use MIL-G-23827 lubricant.
X	Proof-test engine components installers and installer sets				X	Every 12 months except for those parts listed in figure 4-2 which require proof-testing every 6 months. (Refer to paragraph 4-28.)

Figure 4-1. Maintenance Requirements for Engine Components Installers and Installer Sets (Sheet 6 of 6)

ent 90262	Part Number	Nomenclature
	6001-5-3	Sling
	6001-5-4	Sling
	6001-5-5	Sling
X	6001-5-25	Sling
	NAS1210R10J36	Strap
	NAS1210R10J48	Strap
X	2250-38M-3S	Winch-hoist assembly
	9024598	Frame assembly (lower work platform)
X	9026256	Cable assembly (hoist)
	9027184	Cable assembly (positioning)

Figure 4-2. Parts of Components Installers and Installer Sets Requiring Proof-Testing Every 6 Months

a. Immerse shank of ball-lock pin in clean trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302), and actuate ball-lock pin release until existing lubricant is flushed out.

b. While actuating ball-lock pin release, allow cleaning agent to drain from lockpin. Allow lockpin to dry thoroughly.

c. Force gear grease (MIL-G-23827) into ball-lock pin at shank end and around ball-locks while actuating ball-lock pin release.

d. Wipe excessive grease from exterior surfaces of ball-lock pin.

4-8. CEMENTING RUBBER PADS.

4-9. This procedure contains instructions for cementing rubber pads to either metal or wood surfaces.

WARNING

The following procedure uses trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapor or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

a. Clean metal surfaces to be cemented by hand-wiping surfaces with trichloroethylene (MIL-T-27602, trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302), and allow surfaces to dry.

b. Sand wooden surfaces to be cemented, to remove contaminants, and wipe, to remove loose particles.

WARNING

The following procedure uses toluene, which is flammable and must not be used near heat or open flame. It is a toxic solvent. Inhalation of its vapor or prolonged contact with the liquid can cause serious injury or death.

c. Sand the surface of the rubber pads or sheets to be cemented to roughen and remove contaminants. Solvent-wipe with toluene (Federal Specification TT-T-548) and allow to dry.

d. Brush one thin coat of adhesive 584 (Coast Pro-Seal) on each of the surfaces to be cemented. Allow adhesive to become tacky (about 30 minutes).

e. Press surfaces to be cemented firmly together and roll from center to edges, to remove air bubbles and provide complete contact.

f. Allow cemented parts to set at least 24 hours before use.

4-10. CEMENTING TEFLON GASKETS.

WARNING

The following procedure uses trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapor or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

4-11. Clean etched side of Teflon gasket and surface to which it is to be cemented, with trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302). After cleaning, brush a thin coat of adhesive EC776 (Minnesota Mining and Mfg) on each of the surfaces to be cemented (etched side of the Teflon) and allow to dry to tack-free (about 15 minutes). Aline gasket on mating surface and firmly press down with a roller to make certain contact is firm.

4-12. ADJUSTING BRAKES.

4-13. Adjusting brakes consists of positioning each brake to apply the required force, without overloading the brake lever.

4-14. ADJUSTING STOWAGE CART BRAKES.

a. Loosen nuts attaching brake to mounting bracket.

b. Actuate brake lever until nearly over-center and hold. Position brake in serrations, to allow brake shoe to touch wheel. Release brake lever.

c. Move brake one serration maximum toward wheel and torque nuts to 90-110 inch-pounds.

4-15. ADJUSTING COMPONENT CART BRAKES.

a. Loosen locking nut, and screw brake foot away from wheel.

b. Actuate brake lever to limit of travel. Screw brake foot until contact with wheel is made. Release brake.

c. Screw brake foot one turn maximum toward wheel, and torque locking nut 62-80 inch-pounds.

4-16. REPAIRING TRACK SECTION PLUGS AND ADAPTERS.

4-17. Raised material on contacting surfaces of adapters and plugs must be removed as follows: (See figure 4-3 for surface contact areas.)

a. Using 320-grit abrasive cloth or paper, remove burs, scratches, or other raised material until surface is smooth and consistent in height with surrounding surface.

b. Apply touchup chemical film coating (paragraph 4-18) to reworked areas.

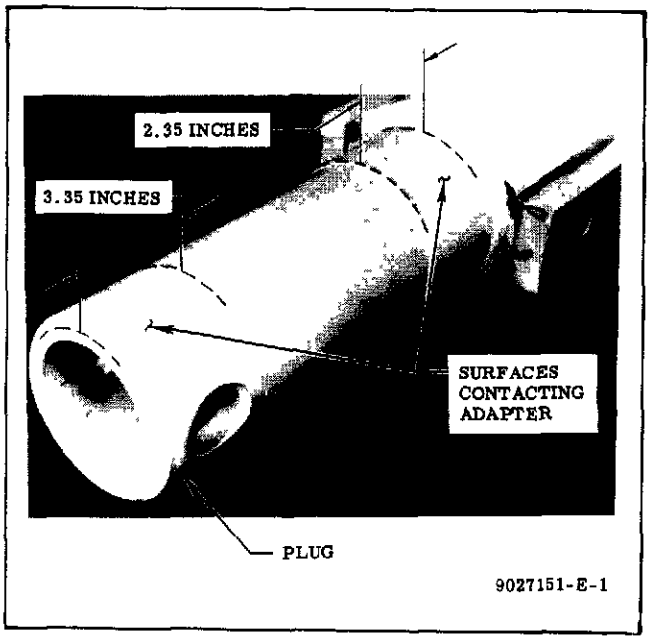

Figure 4-3. Track Section Mating Surfaces

4-18. APPLYING TOUCHUP CHEMICAL FILM COATINGS.

4-19. Small scratches or abrasions on anodized surfaces may be touched up by the brush-on method.

WARNING

The following procedure uses drycleaning solvent, which is flammable and must not be used near heat, sparks, or open flame. Inhalation of its vapors or prolonged contact with the liquid can cause serious injury.

a. Clean part with drycleaning solvent (Federal Specification P-D-680) and dry with a soft, clean cloth.

b. Deoxidize part by applying a mixture of one part, by volume, of cleaning compound (MIL-C-5410, Type II) and one part distilled or deionized water at 65° to 95° F. Use a soft-bristle brush or clean cloth to apply mixture, and keep surface wet for 5-10 minutes.

c. Rinse part in clean, tap water (room temperature), using a spray or wiping with a clean cloth frequently wrung out in clean water. Surface must form an unbroken film.

d. Using a soft-bristle brush, coat part with Iridite 14-2 solution for 3-5 minutes. Coat only small areas at a time. Iridite 14-2 solution is made from 6 ounces of Iridite 14-2 powder (Allied Research Products) plus 0.01 ounce detergent ARP No. 2 (Allied Research Products) per gallon of water.

e. Rinse part by flushing with tap water. Avoid hand-rubbing, since wet film is easily removed.

4-20. APPLYING LUBRICANT TO SLIDING SURFACES.

4-21. Thoroughly coat sliding surfaces, such as pins, trunnions, drivescrews, gears, and chains (see figure 4-4) with fluorolube grease GR362 (Hooker Chemical Corp). Excess grease on the outside of the sliding surfaces must be wiped off.

4-22. ADJUSTING TURNTABLE WHEEL-TO-TRACK RAIL CLEARANCE.

4-23. Adjust turntable wheel-to-track rail clearance as follows:

a. Position turntable on track.

b. Release brake on turntable.

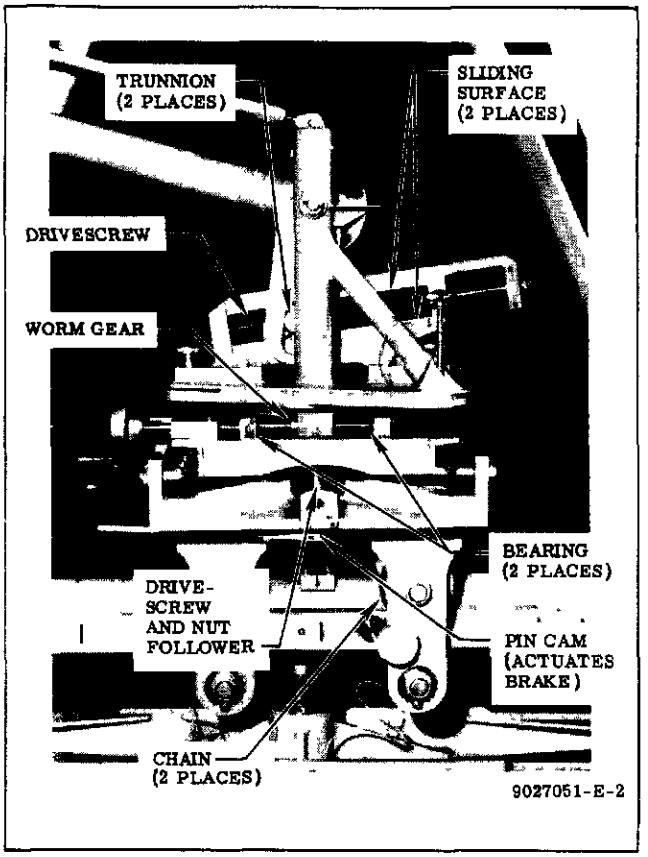

Figure 4-4. Hoist Sliding Surfaces Requiring Lubrication

c. Make sure all upper wheels are contacting rail; then remove screw and washer securing applicable wheel eccentric.

d. Move eccentric until wheel contacts rail; then back off eccentric to first stop that will provide a minimum of 0.010 inch between rail and wheel. Secure eccentric with washer and screw. Torque screw to 19-24 inch-pounds.

e. Verify clearance obtained in step d at 2 additional track positions.

4-24. LUBRICATING WHEEL-FRAME ROTATION BEARINGS.

4-25. Lubricate bearirgs as follows: (See figure 4-5.)

a. Place turntable on work surface in an inverted position and support turntable so that no weight is on control wheels.

CAUTION

In the following procedures, moving plate (horizontal travel) to extreme outboard position causes turntable center of gravity to shift. Plate and turntable must be supported at all times, since damage to equipment can result.

b. Move plate (horizontal travel) to one extreme outboard position, to gain access to screws securing wheel frames to turntable.

c. Remove screws, washers, and nuts (accessible by rotating wheel frames) securing wheel frames to bearing inner support rings: then move plate (horizontal travel) to other extreme outboard position and remove remaining screws, washers, and nuts (accessible by rotating wheel frames).

d. Remove wheel frames and ring spacers.

e. Remove screws and washers securing bearing outer support rings.

f. Separate bearing from inner and outer support rings.

WARNING

The following procedure uses trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapor or prolonged contact with the liquid can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

g. Immerse bearings and races in clean trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302) until existing lubricant is flushed out.

h. Allow bearings and races to dry thoroughly prior to lubricating.

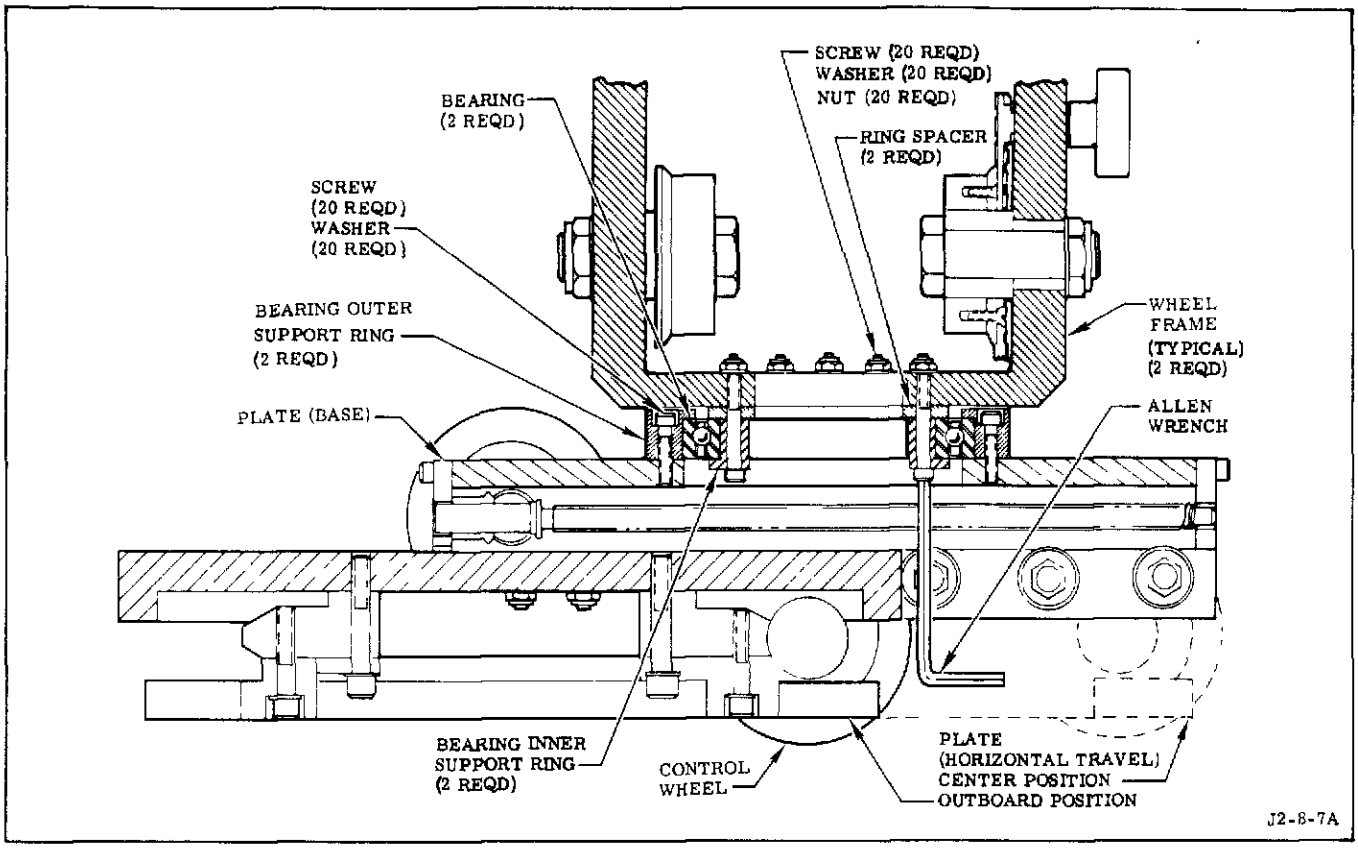

Figure 4-5. Wheel Frame (Cutaway View)

i. Thoroughly coat bearings and races with fluorolube grease GR362 (Hooker Chemical Corp) and hand-pack 1/3 the clearance volume with grease during assembly.

j. Assemble bearings and inner and outer support rings.

k. Install screws and washers securing bearing outer support rings to turntable. Torque screws to 47-61 inch-pounds.

l. Place ring spacers on bearings.

m. Place wheel frames in position on turntable. Wheel frame with chain drive is located farthest from control wheels with chain-drive control knobs located on side of wheel frame nearest control wheels. (See figure 4-4.)

CAUTION

In the following procedure, moving plate (horizontal travel) to extreme outboard positions causes turntable center of gravity to shift. Plate and turntable must be supported at all times, since damage to equipment can result.

n. With plate (horizontal travel) moved to one extreme position, install screws, washers, and nuts (accessible by rotating wheel frames), to secure wheel frames to bearing inner support rings; then move horizontal travel plate to other extreme position and install remaining screws, washers, and nuts (accessible by rotating wheel frames). Torque nuts to 47-61 inch-pounds.

o. Return plate (horizontal travel) to center position.

4-26. LUBRICATING TURNTABLE SUPPORT BEARING.

4-27. Lubricate bearing as follows: (See figure 4-6.)

a. Remove screws and washers securing plate (rotating) and ring spacer to gear. Remove plate (rotating) and ring spacer.

b. Remove screws and washers securing ring (wiper retainer), wiper, ring (bearing support), and gear to turntable. Remove parts and separate gear, bearing, and ring (bearing support).

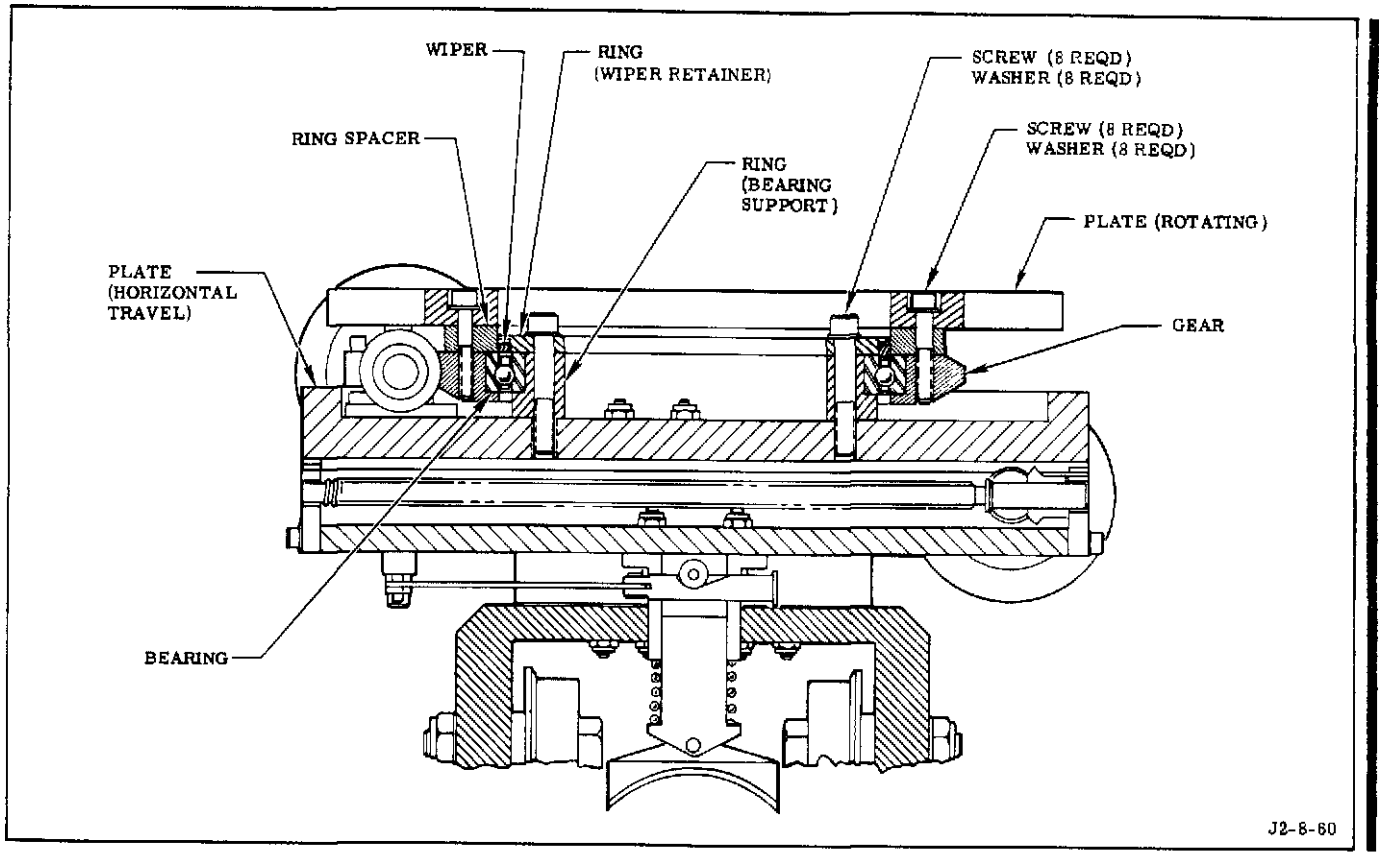

Figure 4-6. Turntable (Cutaway View)

WARNING

The following procedure uses trichloroethylene (MIL-T-27602) or trichloroethane (MIL-T-81533), which are toxic solvents. Inhalation of their vapor or prolonged contact with the liquids can cause serious injury or death.

- The following procedure uses cleaning compound (MIL-C-81302), which is volatile. Use in a well-ventilated area since the vapors displace the oxygen in the air, resulting in suffocation.

c. Immerse bearings and races in clean trichloroethylene (MIL-T-27602), trichloroethane (MIL-T-81533), or cleaning compound (MIL-C-81302) until existing lubricant is flushed out.

d. Allow bearings and races to dry thoroughly prior to lubricating.

e. Thoroughly coat bearings and races with fluorolube grease GR362 (Hooker Chemical Corp), and hand-pack 1/3 the clearance volume with grease during assembly.

f. Assemble bearing, ring (bearing support), and gear.

g. Place bearing, ring (bearing support), and gear in place on plate (horizontal travel).

h. Install wiper and ring (wiper retainer) on bearing and secure with 8 screws and washers. Torque screws to 145-180 inch-pounds.

i. Place ring spacer and plate (rotating) on gear and secure with 8 screws and washers. Torque screws to 90-120 inch-pounds.

4-28. PROOF TESTING.

4-29. Paragraphs 4-30 through 4-58 provide all the requirements for proof testing the 2 Engine Components Installers G4071 and G4072 and the 2 Engine Components Installer sets 9026251 and 9026252. When proof testing an individual installer or installer set, only the paragraphs applicable to that installer or installer set need be performed. To determine which of the paragraphs are applicable, see figure 4-7. Figure 4-7 lists in an alphanumeric sequence, all the parts contained in the installers and installer sets, identifies to which installer or installer set the parts belong, lists the paragraph number in which the proof-test

'ata can be found, and the required proof-load weight. Performing all the paragraphs associated with an individual installer or installer set constitutes the complete proof-test requirements for that item. Listing proof loads identifies all the requirements for an individual proof load, an aid in the efficient performance of the proof-test requirements. Additionally, if due to replacement, repair or modification it is necessary to proof-test an individual part, figure 4-7 can be used to locate the data for that part. Where more than one part is proof tested by a procedure, the procedure specifies the parts required and identifies the shelf of the stowage cart on which the part can be found. When the number of parts required is extensive, the parts are listed in a figure in the suggested order of removal from the cart. Refer to section II for information on unloading cart and section I for identification of shelf numbers. Proof testing subjects the engine components installers and installer sets to load forces equal to twice the maximum work loads. Proof testing the equipment must be performed as follows:

a. Loads applied evenly and to points specified in the procedures.

b. Loads lifted or suspended a minimum distance from the floor. (It is necessary only to have the proof-test weight clear the floor, except where otherwise noted.)

c. Loads may be applied by methods other than suspending proof-test weight, providing all test requirements are satisfied.

Component of				Part Number	Nomenclature	Procedure (Paragraph Number)	Proof-Test Weight (Pounds)
G4071	G4072	9026251	9026252				
X	X			NAS1213R10J36	Strap	4-46	1,120
X	X			NAS1213R10J48	Strap	4-46	1,120
		X	X	2250-38M-3S	Winch-hoist	4-51	1,600
X	X			6001-5-3	Sling	4-46	1,120
X	X			6001-5-4	Sling	4-46	1,120
X	X			6001-5-5	Sling	4-46	1,120
		X	X	6001-5-25	Sling	4-46	1,600
	X	X		9024539	Engine component handler	4-47	700
	X	X		9024543	Engine component hanger	4-48	1,200
	X	X		9024547	Engine component pickup adapter	4-49	1,120
	X			9024598-1	Frame	4-55	400
	X			9024598-2	Frame	4-55	400
X	X			9024600	Hook	4-30(a),4-53(b)	1,120
	X			9025848	Platform	4-55	400
X				9025865	Stowage cart	4-59	12,400

(a) G4071 only
(b) G4072 only

Figure 4-7. Location of Proof-Test Procedure for an Individual Part of the Components Installers and Components Installer Sets (Sheet 1 of 4)

Component of				Part Number	Nomenclature	Procedure (Paragraph Number)	Proof-Test Weight (Pounds)
G4071	G4072	9026251	9026252				
	X			9025870	Stowage cart	4-59	7,200
X	X			9025874	Fuel exhaust duct handler	4-34	150
X				9026189	Start tank handler	4-44	200
		X	X	9026253	Component handling cart	4-61	1,200
		X	X	9026256	Installer sling cable	4-50	6,520
		X		9026259	Base	4-30	1,120
		X		9026260	Track section	4-30	1,120
		X		9026260-11	Track section	4-30	1,120
		X		9026270	Strut	4-30	1,120
X	X			9026942	Primary flight instrumentation package handler	4-35	66
X	X			9026977	LOX and fuel turbopump handler	4-36	880
			X	9026990	Base	4-54	1,120
			X	9026991	Extension	4-54	1,120
			X	9026991-11	Extension	4-54	1,120
			X	9026993	Support	4-54	1,120
			X	9026997	Adapter	4-56	880
X	X			9027051	Boom	4-30[a],4-53[b]	1,120
	X			9027080	Extension	4-53	1,120
	X			9027084	Sleeve	4-53	1,120
	X			9027084-11	Sleeve	4-53	1,120
		X	X	9027095	Chain hoist	4-52	1,120
X	X			9027101	Turntable	4-30[a],4-53[b]	1,120
X				9027151	Track section	4-30	1,120
X				9027152	Track section	4-30	1,120
X				9027153	Track section	4-30	1,120
X				9027154	Track section	4-30	1,120
X				9027155	Track section	4-30	1,120
X	X		X	9027156	Stop	4-30[a],4-53[b], 4-54[c]	1,120

(a) G4071 only
(b) G4072 only
(c) 9026252 only

Figure 4-7. Location of Proof-Test Procedure for an Individual Part of the Components Installers and Components Installer Sets (Sheet 2 of 4)

Component of				Part Number	Nomenclature	Procedure (Paragraph Number)	Proof-Test Weight (Pounds)
G4071	G4072	9026251	9026252				
X				9027157	Track section	4-30	1,120
X				9027158	Track section	4-30	1,120
X				9027158-11	Track section	4-30	1,120
X				9027158-21	Track section	4-30	1,120
X				9027159	Stop	4-30	1,120
X	X			9027160	Track pin	4-30(a),4-53(b)	1,120
X	X		X	9027161	Support pin	4-30(a),4-53(b), 4-54(c)	1,120
	X			9027162	Track	4-53	1,120
	X			9027163	Track	4-53	1,120
	X			9027163-11	Track	4-53	1,120
	X			9027163-21	Track	4-53	1,120
	X			9027163-31	Track	4-53	1,120
	X			9027163-41	Track	4-53	1,120
	X			9027164	Base	4-53	1,120
	X			9027169	Pin	4-57	1,120
	X			9027170	Adapter	4-57	1,120
X				9027172	Component handling angle adapter	4-37	300
X				9027174	Component handler adapter	4-38	1,120
X				9027178	Strut	4-39	2,000
X				9027178-11	Strut	4-39	2,000
X				9027182	Bracket	4-40	2,000
X				9027182-11	Bracket	4-40	2,000
X				9027182-21	Bracket	4-40	2,000
X				9027184	Platform positioning cable	4-42	400
X				9027185	Turnbuckle	4-43	1,200
X				9027186	Base	4-30	1,120
X				9027187	Base	4-30	1,120
X				9027187-11	Base	4-30	1,120
X				9027188	Beam	4-30	1,120

(a) G4071 only
(b) G4072 only
(c) 9026252 only

Figure 4-7. Location of Proof-Test Procedure for an Individual Part of the Components Installers and Components Installer Sets (Sheet 3 of 4)

Component of				Part Number	Nomenclature	Procedure (Paragraph Number)	Proof-Test Weight (Pounds)
G4071	G4072	9026251	9026252				
X				9027190	Platform	4-30(d),4-41(d)	1,120
X	X			9027196	Extension	4-30(a),4-53(b)	1,120
X		X		9027196-11	Extension	4-30	1,120
X				9027196-21	Extension	4-30	1,120
			X	9027196-31	Extension	4-54	1,120
X				9027200	Support	4-30	1,120
X	X			9027211	Platform	4-33	500
	X			9027216	Cover	4-60	500
X	X			9027219	Base	4-33	500
X	X			9027225	Auxiliary flight instrumentation package handler	4-35	60
X	X			9027226-1	Turnbuckle	4-31(a)(e), 4-32(a)(e), 4-58(b)	7,600
X	X			9027226-2	Turnbuckle	4-32(a), 4-58(b)	7,600
X				9027226-11	Turnbuckle	4-31	7,600
X	X			9027231	Bracket	4-31(a)(e), 4-32(a)(e), 4-58(b)	7,600
X	X			9027232	Bracket	4-31(a)(e), 4-32(a)(e), 4-58(b)	7,600
X				9027248	Bracket	4-31	7,600
X				9027249-11	Frame	4-31	7,600
X				9027249-12	Frame	4-31	7,600
	X			9027254-1	Frame	4-58	7,600
	X			9027254-2	Frame	4-58	7,600
	X			9027257	Bracket	4-58	7,600
X	X			9027258-1	Beam	4-31(a), 4-58(b)	7,600
	X			9027258-2	Beam	4-58	7,600
X				9027258-11	Beam	4-31	7,600
X				9027259-1	Bracket	4-32	7,600
X				9027259-2	Bracket	4-32	7,600
X	X			9027263	Gimbal and injector handler	4-45	600

(a) G4071 only
(b) G4072 only
(d) Performance of both paragraphs (4-30 and 4-41) must be accomplished for complete proof test.
(e) Performance of either paragraph (4-31 or 4-32) will satisfy proof-test requirement.

Figure 4-7. Location of Proof-Test Procedure for an Individual Part of the Components Installers and Components Installer Sets (Sheet 4 of 4)

F-TESTING TRACK AND HOIST
)026). This task requires a
e wc ng area 35 feet square,
n overhead hoist or forklift capa-
1, 120 pounds.

.he following tools and equipment:

1/2-inch spanner wrench No. 462
ıs and Co), or equivalent

120 ±20 pound proof-test weight.
ight must be capable of being
ıd of boom 9027051 and not exceed
eight from centerline of attach

NOTE

est procedures require proof
be suspended over track with
n horizontal or near horizon-
proof-test weight that exceeds
:s in height from centerline
h hole may not clear the track.

)rts, to elevate track, as shown
, or equivalent. Supports must
supporting 1, 600 pounds each.

ue wrench, 0-150 inch-pounds

b. Obtain Engine Components Installer G4071 parts listed in figure 4-8 and assemble track configuration illustrated in figure 4-9, or obtain Engine Components Installer G4071 and engine components installer set 9026251 parts listed in figure 4-10 and assemble track configuration illustrated in figure 4-11. Assemble either configuration, observing the following requirements:

NOTE

Both track configurations require proof testing, however, since common parts are used in each configuration, only one can be assembled at a time. It is optional as to which configuration is assembled first.

CAUTION

Mating portions of track sections are close tolerance fits. Dirt or damage could prevent assembly or make disassembly difficult.

(1) Before mating, make sure track ends (plugs and adapters) are clean and free of burs or damage that could impair mating of the track sections.

e	Part Number	Number Required (One Unless Noted)	Shelf Number
ı	9027152 (Numbered 9-18)		5
ı	9027153 (Numbered 19-28)		5
ı	9027151 (Numbered 1-8)		5
	9027156	2	5
	9027200	3	4
ı	9027154 (Not numbered)		4
ı	9027155 (Not numbered)	4	4
	9027187	13	2
	9027187-11	3	2
	9027101		2
	9027051		2
	9027196-21	16	1
	9027161	16	1
	9027160	9	1
	9024600		1

ure 4-8. G4071 Parts Required for Proof-Testing Track Configuration No. 1

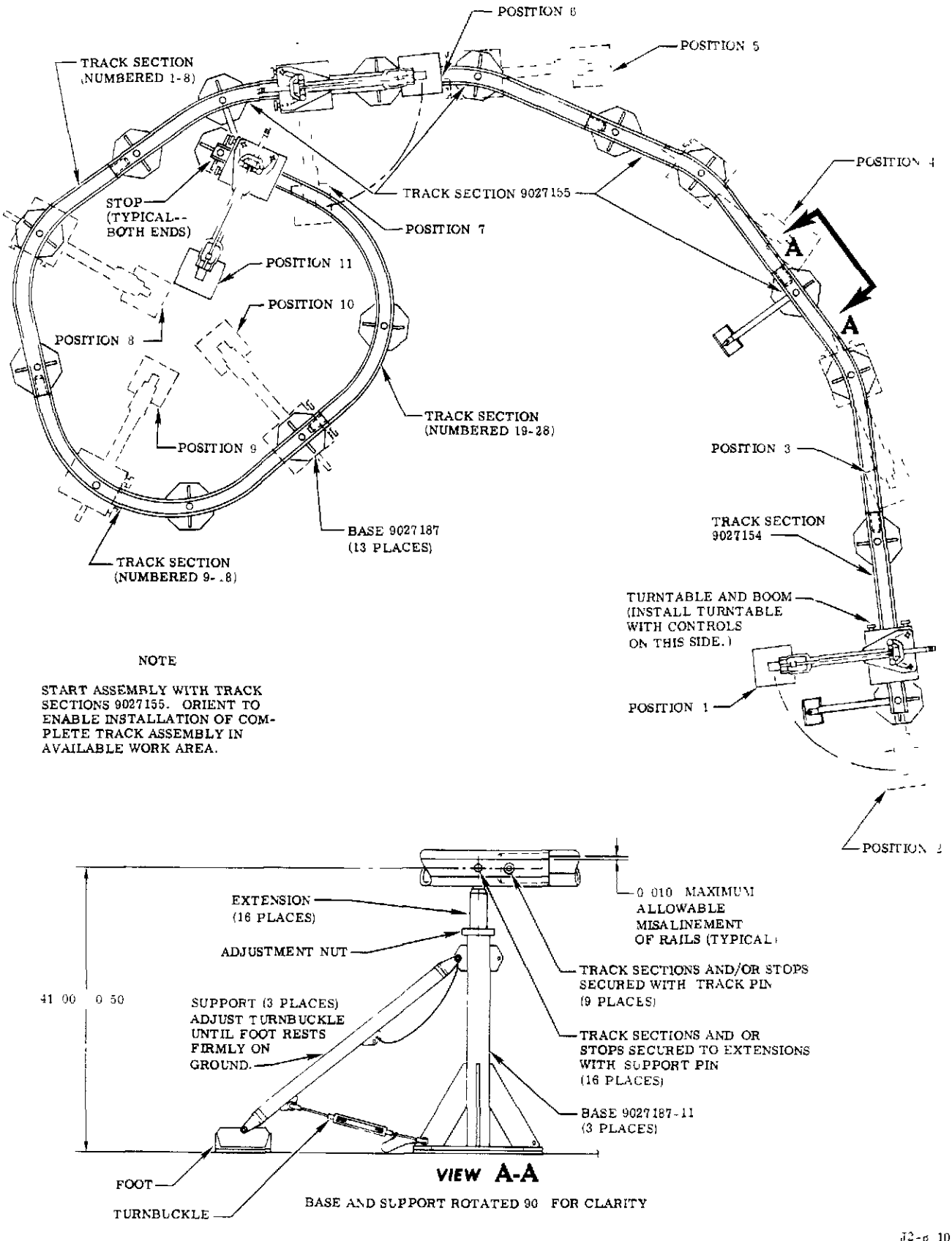
POSITION 6
POSITION 5
TRACK SECTION (NUMBERED 1-8)
POSITION 4
STOP (TYPICAL-- BOTH ENDS)
TRACK SECTION 9027155
POSITION 7
A
A
POSITION 11
POSITION 10
POSITION 8
TRACK SECTION (NUMBERED 19-28)
POSITION 9
POSITION 3
TRACK SECTION 9027154
BASE 9027187 (13 PLACES)
TRACK SECTION (NUMBERED 9-.8)
TURNTABLE AND BOOM (INSTALL TURNTABLE WITH CONTROLS ON THIS SIDE.)
NOTE
START ASSEMBLY WITH TRACK SECTIONS 9027155. ORIENT TO ENABLE INSTALLATION OF COMPLETE TRACK ASSEMBLY IN AVAILABLE WORK AREA.
POSITION 1
POSITION 2
EXTENSION (16 PLACES)
0 010 MAXIMUM ALLOWABLE MISALINEMENT OF RAILS (TYPICAL)
ADJUSTMENT NUT
TRACK SECTIONS AND/OR STOPS SECURED WITH TRACK PIN (9 PLACES)
41 00 0 50
SUPPORT (3 PLACES) ADJUST TURNBUCKLE UNTIL FOOT RESTS FIRMLY ON GROUND.
TRACK SECTIONS AND OR STOPS SECURED TO EXTENSIONS WITH SUPPORT PIN (16 PLACES)
BASE 9027187-11 (3 PLACES)
VIEW A-A
FOOT
TURNBUCKLE
BASE AND SUPPORT ROTATED 90 FOR CLARITY
J2-6 10

Figure 4-9. Track Configuration No. 1 and Proof-Test Positions (G4071)

Nomenclature	Part Number	Number Required (One Unless Noted)	Shelf Number
Track section	9027158 (Numbered 5-12)		5
Track section	9027158-11 (Numbered 13-20)		5
Track section	9027158-21 (Numbered 21-28)		5
Stop	9027156		5
Stop	9027159		5
Track section	9027157 (Numbered 1-4)		4
Track section	9027154		4
Support	9027200	3	4
Beam	9027188	4	3
Base	9027186	9	3
Base	9027187		2
Base	9027187-11	3	2
Turntable	9027101		2
Boom	9027051		2
Extension	9027196-11	5	1
Extension	9027196	9	1
Support pin	9027161	14	1
Track pin	9027160	8	1
Hook	9024600		1
Platform[a]	9027190	4	-
Track section	9026260		(b)
Track section	9026260-11		(b)
Base	9026259		(b)
Strut	9026270		(b)

(a) Partially proof tested in this procedure. To be fully proof tested, the requirements of paragraph 4-41 must be included.
(b) Parts from engine components installer set

Figure 4-10. G4071 and 9026251 Parts Required for Proof-Testing Track Configuration No. 2

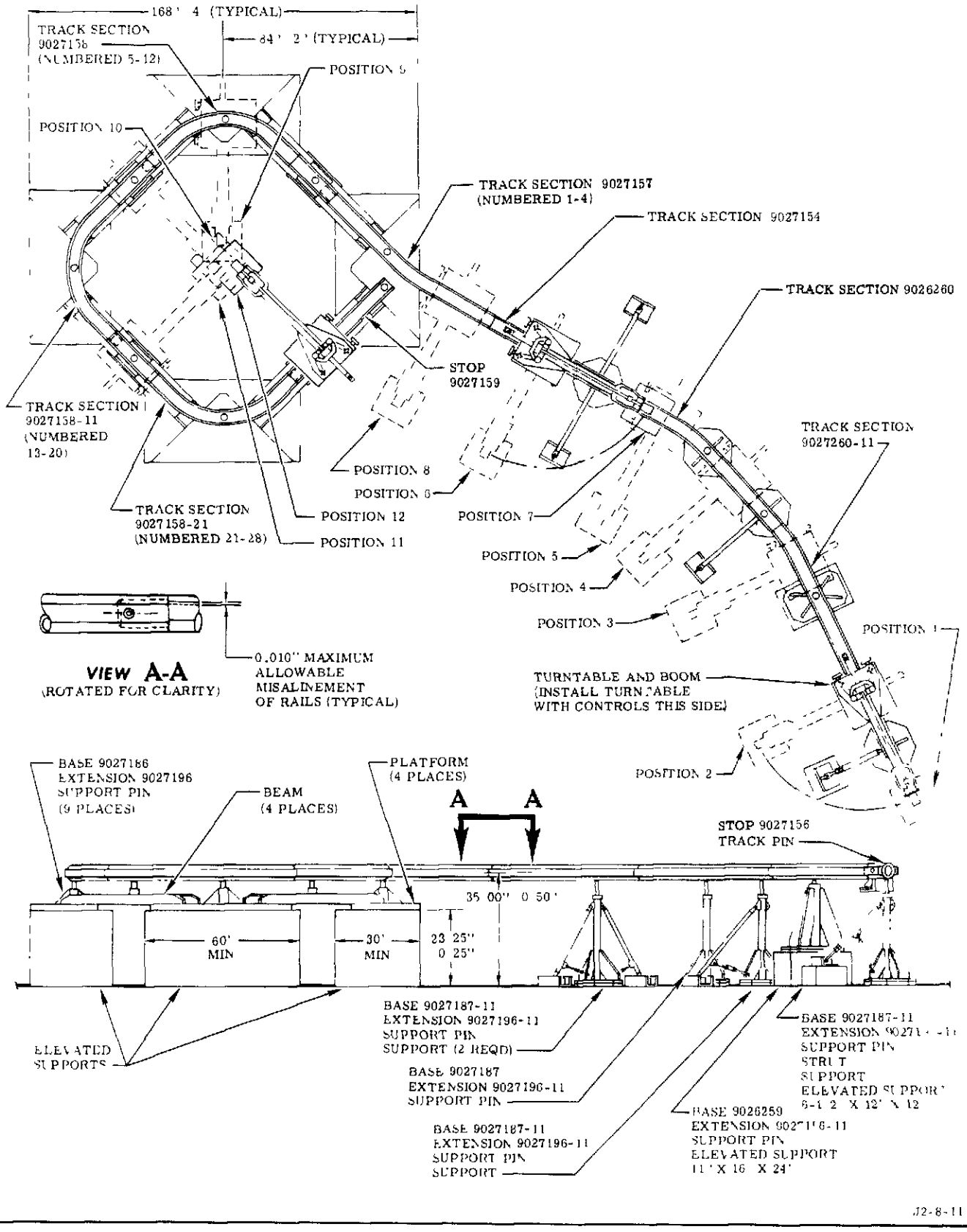
168' 4" (TYPICAL)
64' 2" (TYPICAL)
TRACK SECTION 9027156 (NUMBERED 5-12)
POSITION 9
POSITION 10
TRACK SECTION 9027157 (NUMBERED 1-4)
TRACK SECTION 9027154
TRACK SECTION 9026260
STOP 9027159
TRACK SECTION 9027158-11 (NUMBERED 13-20)
TRACK SECTION 9027260-11
POSITION 8
POSITION 6
TRACK SECTION 9027158-21 (NUMBERED 21-28)
POSITION 12
POSITION 11
POSITION 7
POSITION 5
POSITION 4
POSITION 3
POSITION 1
POSITION 2
VIEW A-A (ROTATED FOR CLARITY)
0.010" MAXIMUM ALLOWABLE MISALINEMENT OF RAILS (TYPICAL)
TURNTABLE AND BOOM (INSTALL TURNTABLE WITH CONTROLS THIS SIDE)
BASE 9027186 EXTENSION 9027196 SUPPORT PIN (9 PLACES)
BEAM (4 PLACES)
PLATFORM (4 PLACES)
A A
STOP 9027156 TRACK PIN
35 00" 0 50"
60' MIN
30' MIN
23 25" 0 25"
ELEVATED SUPPORTS
BASE 9027187-11 EXTENSION 9027196-11 SUPPORT PIN SUPPORT (2 REQD)
BASE 9027187 EXTENSION 9027196-11 SUPPORT PIN
BASE 9027187-11 EXTENSION 9027196-11 SUPPORT PIN SUPPORT
BASE 9026259 EXTENSION 9027196-11 SUPPORT PIN ELEVATED SUPPORT 11' X 16' X 24'
BASE 9027187-11 EXTENSION 9027196-11 SUPPORT PIN STRUT SUPPORT ELEVATED SUPPORT 6-1/2" X 12" X 12"
J2-8-11

Figure 4-11. Track Configuration No. 2 and Proof-Test Positions (G4071)

(2) Mate track sections carefully, to prevent damage to contacting surfaces. (See figure 4-3.)

(3) Secure each extension to track or stops with a support pin. Tigthten support pins sufficiently, to seat head of pin.

(4) Secure each mated track joint with a track pin. Make sure track pins do not protrude beyond outer surfaces of track.

(5) Before installing last stop, install turntable on track, with controls positioned as noted on illustration. If in doubt as to how turntable installs, see figure 4-4 for an installed view.

(6) Adjust height of track by rotating adjusting nuts with spanner wrench. If nut is difficult to rotate, lubricate threads, using Molykote G paste (Dow Corning Corp).

(7) Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. (See figure 4-9.) Adjust extension as necessary to aline, maintaining track elevation within required height.

NOTE

Misalinement of rails exceeding wheel-to-track clearance can prevent movement of hoist over track joint.

(8) Tighten bolts that secure boom to turntable hand-tight.

(9) Secure hook to boom socket with hook latch arm on top and vertical.

WARNING

The following procedure subjects the equipment to extreme loads. Failure of a part under load could cause part to whip or be projected at velocities that can cause injury or death.

d. Proof-test by suspending proof-test weight for a minimum of 3 minutes at each of the positions identified. (See figures 4-9 and 4-11.) Sequence is optional. The following requirements must be complied with:

(1) Only those persons necessary for the performance of this task should be allowed in the immediate vicinity.

CAUTION

In the following procedure, raising the boom with proof load applied will cause the pin in the boom drive adapter to shear.

(2) Before connecting proof-test weight to boom, position boom above horizontal so that when proof load is applied, boom will not deflect below horizontal. If boom does deflect below horizontal, remove proof load and reposition boom higher. Do not raise boom with proof load applied. If boom remains above horizontal with proof load applied, lower it to near horizontal with the boom controls.

(3) When changing positions, which requires moving hoist along track, remove proof load from hoist before moving hoist.

(4) Apply turntable brake at all times, except when hoist is being installed or moved along track.

(5) When proof-test position requires load to be suspended to side of track, turntable must be positioned laterally full, toward side of track load is suspended from. Lateral position of turntable must be accomplished prior to applying proof load to hoist.

CAUTION

In the following procedure, rotating the proof load in an arc other than shown can cause an unstable condition, where the proof load could overbalance the track and cause the track to lift off the ground.

(6) When proof-test position requires proof load to be rotated from side to over the track, or vice versa, turntable must be positioned laterally, full toward side of track, load is rotated from or to. Lateral position of turntable must be accomplished prior to applying proof load to hoist. Rotate proof load only in arc shown.

e. When proof load has been applied to all positions shown in the applicable figure, remove proof load and visually inspect all tested components for signs of structural damage or permanent deformation.

f. Repeat steps b through e, for untested configuration.

g. Prior to disassembly (step h), the hoist as presently mounted may be used as a holding fixture to proof-test parts whose proof-test weight does not exceed the 600-pound or 23,000-inch-pounds working capacity of the hoist. The following parts can be proof tested using the hoist as a holding fixture.

(1) Fuel turbine exhaust duct handler 9025874

(2) Start tank handler 9026189

(3) Primary flight instrumentation package handler 9026942

(4) Component handling angle adapter 9027172

(5) Auxiliary flight instrumentation package handler 9027225

h. Disassemble proof-test setup. Return acceptable proof-tested parts of G4071 to their respective locations on stowage cart. See figures 4-8 and 4-10 or section I for shelf numbers parts are stored on.

4-31. PROOF-TESTING ENGINE LOWERING SYSTEM (ENGINE POSITIONS 1 THROUGH 4). This task requires a working area serviced by an overhead hoist having a minimum capacity of 8,000 pounds.

a. Obtain the following:

(1) Vertical installer and engine sling proof-test weight 9025145, or equivalent. Hoist assembly 9026679 (part of the proof-test weight is not required for this task.

(2) Adapters EWR828272-1 and EWR828272-2, or equivalent

(3) Engine lowering fixture XEOR923020, or equivalent

(4) Torque wrenches capable of torquing 330-430, 520-680, and 1,140-1,260 inch-pounds

(5) Six-inch level

b. Obtain Engine Components Installer G4071 parts listed in figure 4-12.

c. Make sure turnbuckle 9027226-11 is prepared for use. Turnbuckle must have turnbuckle subassemblies 9027226-31 and 9027226-51 installed. If in doubt whether turnbuckle is prepared, refer to section II for information on preparing turnbuckle for use.

d. Position proof-test weight in area serviced by overhead hoist.

Nomenclature	Part Number	Number Required (One Unless Noted)	Shelf Number
Frame	9027249-12		2
Frame	9027249-11		2
Turnbuckle(a)	9027226-1		2
Bracket(a)	9027232		2
Bracket	9027231		(b)
Bolt(c)	9027227	4	2
Bracket	9027248		2
Beam	9027258-11		2
Beam	9027258-1		2
Turnbuckle	9027226-11		3

(a) Stored assembled
(b) May be stored attached to turnbuckle 9027226-2 (shelf 2) or turnbuckle 9027226-11 (shelf 3).
(c) Captive in bracket 9027231

Figure 4-12. G4071 Parts Required for Proof-Testing Engine Lowering System (Engine Positions 1 Through 4)

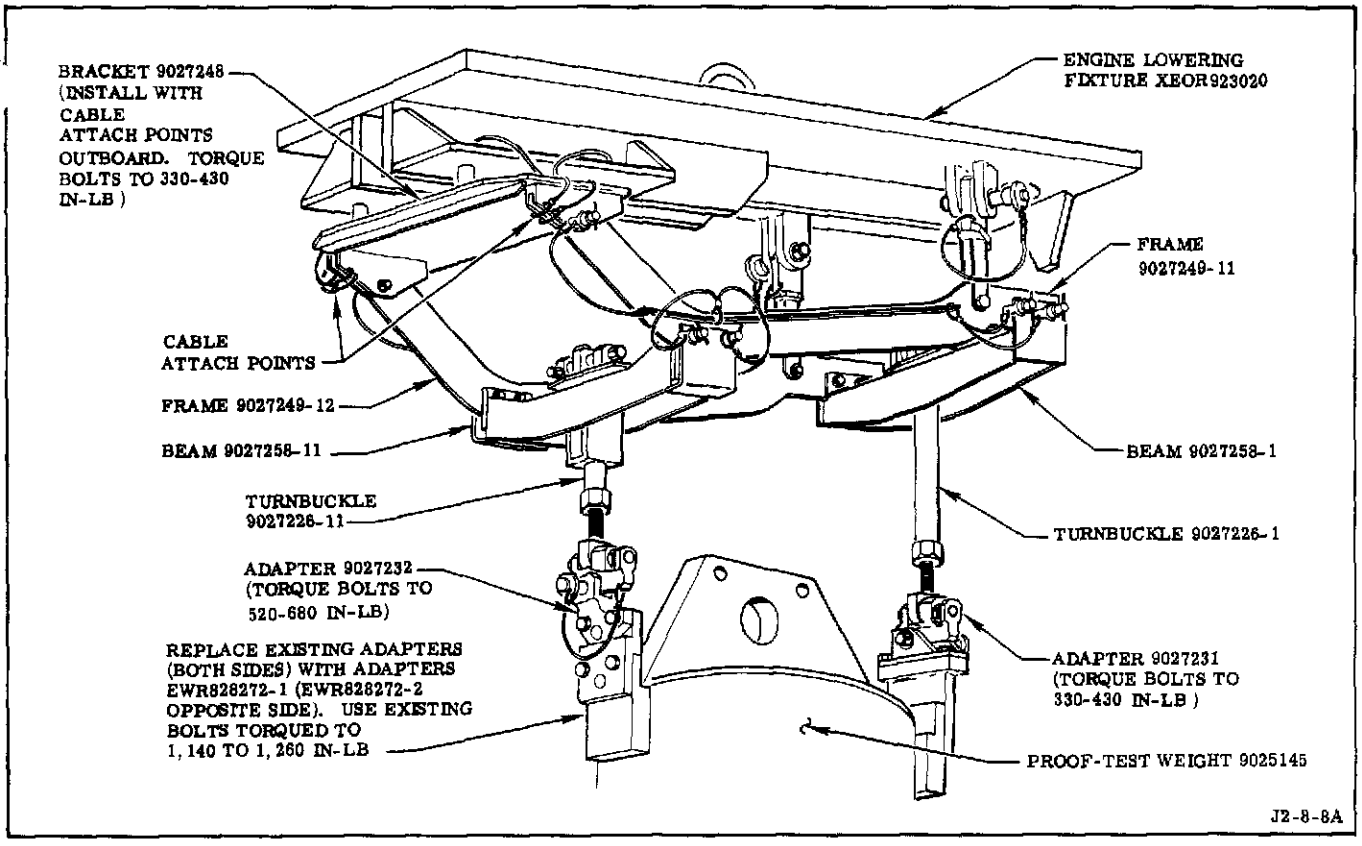
BRACKET 9027248 (INSTALL WITH CABLE ATTACH POINTS OUTBOARD. TORQUE BOLTS TO 330-430 IN-LB)
ENGINE LOWERING FIXTURE XEOR923020
FRAME 9027249-11
CABLE ATTACH POINTS
FRAME 9027249-12
BEAM 9027258-11
BEAM 9027258-1
TURNBUCKLE 9027226-11
TURNBUCKLE 9027226-1
ADAPTER 9027232 (TORQUE BOLTS TO 520-680 IN-LB)
REPLACE EXISTING ADAPTERS (BOTH SIDES) WITH ADAPTERS EWR828272-1 (EWR828272-2 OPPOSITE SIDE). USE EXISTING BOLTS TORQUED TO 1,140 TO 1,260 IN-LB
ADAPTER 9027231 (TORQUE BOLTS TO 330-430 IN-LB)
PROOF-TEST WEIGHT 9025145
J2-8-8A

Figure 4-13. Proof-Test Setup for Engine Lowering System (Engine Positions 1 Through 4)

e. Attach engine lowering fixture to hoist.

f. Assemble engine lowering system, attaching it to engine lowering fixture XEOR923020 and to proof-test weight. (See figure 4-13.) Observe the following:

(1) Maintain engine lowering fixture level while attaching engine lowering system. (This can be accomplished by use of an auxiliary hoist.)

NOTE

Assembly of the lowering system is difficult with lowering fixture at an angle.

CAUTION

The lowering fixture is heavy. Swinging or other movement could impart sufficient side loads to damage the turnbuckles.

(2) Prevent swinging or movement of lowering fixture that could result in side loads on turnbuckles.

(3) Install turnbuckles in beams, before attaching beams to frames. Install turnbuckles by inserting lower end of turnbuckle through beam (figure 4-14) and engaging upper adjusting mechanism to studs in beam. Prior to installing turnbuckles, rod end must be positioned fully to side as shown in figure 4-14.

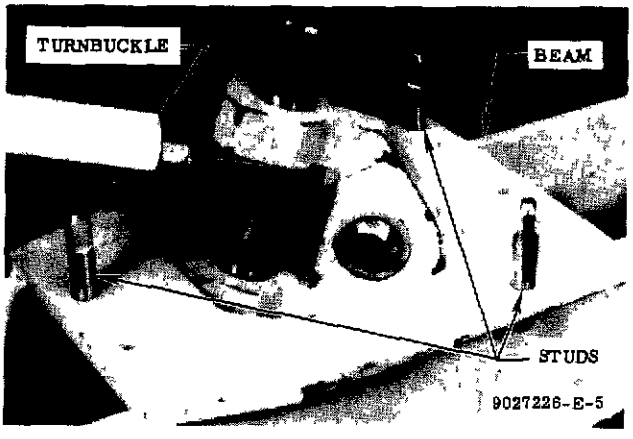

Figure 4-14. Inserting Turnbuckle Through Beam

(4) When attaching beams to frames, rotate beams so that adjustments at top of turnbuckle are toward operator.

(5) Turnbuckles are to be fully extended when attached to proof weight.

(6) Subsequent to installing turnbuckles in beams, position lower end of turnbuckle to dimension shown in figure 3-26.

g. Double-check assembly. All quick-disconnect pins must be fully inserted, bolts seated and torqued, and turnbuckles extended to their maximum length.

h. Raise hoist sufficiently to remove slack in lowering system; then, with level, check that turnbuckles are vertical. Adjust turnbuckles to vertical by using adjustments at top of turnbuckles and/or repositioning hoist.

WARNING

In the following procedure, adjusting the lower end of the turnbuckles other than as shown in figure 3-26 can induce bending moments in the turnbuckles, which will cause the turnbuckles to break, resulting in injury or death to personnel and damage to equipment.

i. Make sure lower end of turnbuckles are positioned to dimension shown in figure 3-26; then cautiously raise proof weight until suspended. Do not raise proof weight more than necessary to clear floor. It is not necessary that proof weight hang vertical.

j. Keep proof weight suspended for a minimum of 3 minutes, then lower it.

k. Visually inspect lowering system for signs of structural failure or permanent deformation.

l. Disassemble proof-test setup. Return acceptable proof-tested parts of G4071 to their respective locations on stowage cart. See figure 4-12 or section I for shelf numbers parts are stored on.

4-32. PROOF-TESTING ENGINE LOWERING SYSTEM (ENGINE POSITION 5). This task requires a working area serviced by an overhead hoist having a minimum capacity of 8,000 pounds.

a. Obtain the following:

(1) Vertical installer and engine slings proof-test weight 9025145, or equivalent. Hoist assembly 9026679 (part of the proof-test weight) is not required for this task.

(2) Adapters EWR828272-1 and EWR828272-2 or equivalent

(3) Engine lowering fixture XEOR923020, or equivalent

(4) Torque wrenches capable of torquing 330-430, 520-680, and 1,140-1,260 inch-pounds

(5) Six-inch level

b. Obtain Engine Components Installer G4071 parts listed in figure 4-15.

c. Make sure turnbuckle 9027226-2 is prepared for use. If in doubt whether turnbuckle is prepared, refer to section II for preparing turnbuckle for use. Turnbuckle 9027226-2 is made up of turnbuckle subassemblies 9027226-31, 9027226-51, and 9027226-61.

d. Position proof-test weight in area serviced by overhead hoist.

e. Attach engine lowering fixture to hoist.

f. Assemble engine lowering system, attaching it to engine lowering fixture XEOR923020 and to proof-test weight. (See figure 4-16.) Observe the following:

1) Maintain engine lowering fixture level while attaching engine lowering system; this can be accomplished by use of an auxiliary hoist.

NOTE

Assembly of the lowering system is difficult with lowering fixture at an angle.

CAUTION

The lowering fixture is heavy. Swinging or other movement could impart sufficient side loads to damage the turnbuckles.

(2) Prevent swinging or movement of the lowering fixture that could result in side loads on turnbuckles.

Nomenclature	Part Number	Number Required (One Unless Noted)	Shelf Number
Bracket(a)	9027232		2
Bracket	9027231		(b)
Turnbuckle(a)	9027226-1		2
Turnbuckle	9027226-2		2
Bracket	9027259-1		2
Bracket	9027259-2		2
Bolts(c)	9027227	4	2

(a) Stored assembled
(b) May be stored attached to turnbuckle 9027226-2 (shelf 2) or turnbuckle 9027226-11 (shelf 3).
(c) Captive in bracket 9027231

Figure 4-15. G4071 Parts Required for Proof-Testing Engine Lowering System (Engine Position 5)

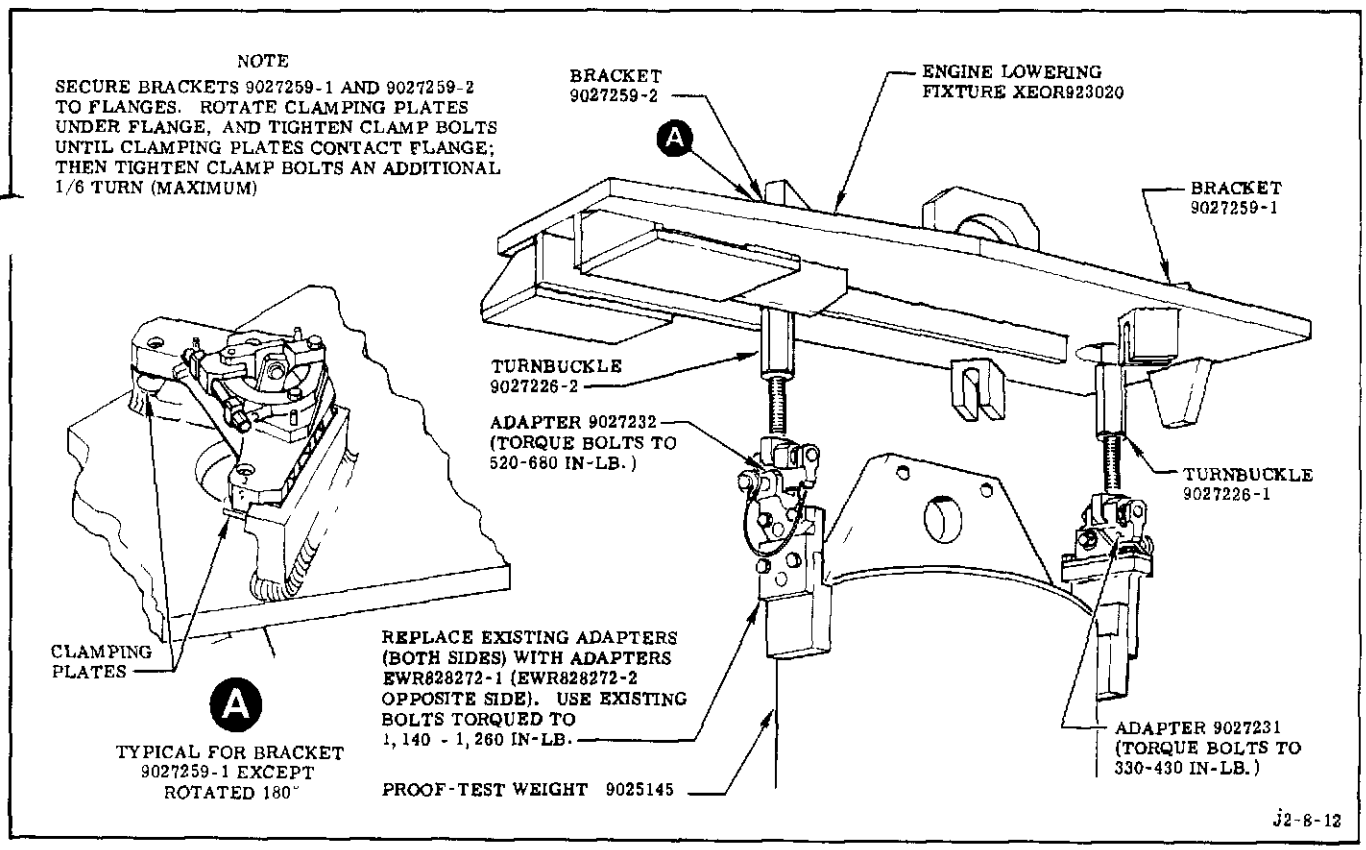
NOTE
SECURE BRACKETS 9027259-1 AND 9027259-2 TO FLANGES. ROTATE CLAMPING PLATES UNDER FLANGE, AND TIGHTEN CLAMP BOLTS UNTIL CLAMPING PLATES CONTACT FLANGE; THEN TIGHTEN CLAMP BOLTS AN ADDITIONAL 1/6 TURN (MAXIMUM)
BRACKET 9027259-2
ENGINE LOWERING FIXTURE XEOR923020
A
BRACKET 9027259-1
TURNBUCKLE 9027226-2
ADAPTER 9027232 (TORQUE BOLTS TO 520-680 IN-LB.)
TURNBUCKLE 9027226-1
CLAMPING PLATES
A
TYPICAL FOR BRACKET 9027259-1 EXCEPT ROTATED 180°
REPLACE EXISTING ADAPTERS (BOTH SIDES) WITH ADAPTERS EWR828272-1 (EWR828272-2 OPPOSITE SIDE). USE EXISTING BOLTS TORQUED TO 1,140 - 1,260 IN-LB.
PROOF-TEST WEIGHT 9025145
ADAPTER 9027231 (TORQUE BOLTS TO 330-430 IN-LB.)
J2-8-12

Figure 4-16. Proof-Test Setup for Engine Lowering System (Engine Position 5)

(3) Install turnbuckles into brackets by inserting lower end of turnbuckles through brackets and engaging upper adjusting mechanism to studs in beam. Prior to installing turnbuckles, make sure rod end is positioned fully to side as shown in figure 4-17.

Figure 4-17. Inserting Turnbuckle Through Bracket

(4) Turnbuckles are to be fully extended when attached to proof weight.

(5) Subsequent to installing turnbuckles in beams, position lower end of turnbuckle to dimension shown in figure 3-26

f. Double-check assembly. All quick-disconnect pins must be fully inserted, bolts seated and torqued, and turnbuckles extended to their maximum length.

g. Raise hoist sufficiently to remove slack in lowering system, then, with level, check that turnbuckles are vertical. Adjust turnbuckles to vertical by using adjustments at top of turnbuckles and/or repositioning hoist.

WARNING

In the following procedure, adjusting the lower end of the turnbuckles other than as shown in figure 3-26 can induce bending moments in the turnbuckles that will cause the turnbuckles to break, resulting in injury or death to personnel and damage to equipment.

h. Make sure lower end of turnbuckles are positioned to dimension shown in figure 3-26 then cautiously raise proof-test weight until suspended. Do not raise proof-test weight more than necessary to clear floor. It is not necessary that proof-test weight hang vertical.

i. Keep proof-test weight suspended for a minimum of 3 minutes, then lower it.

j. Visually inspect lowering system for signs of structural damage or permanent deformation.

k. Disassemble proof-test setup. Return acceptable proof-tested parts of G4071 to their respective storage locations on stowage cart. See figure 4-15 or section I for shelf numbers parts are stored on.

4-33. PROOF-TESTING ENGINE INTERNAL ACCESS PLATFORM. This test requires an area with a vertical support or wall capable of supporting the access platform with a 500-pound proof-weight applied (figure 4-18).

a. Obtain a torque wrench capable of torquing 90-120 inch-pounds and a 500 ±10 pound proof-test weight. Area of proof-test weight that will bear on platform must be a minimum of one square foot. (Sand bags, lead weights, or similar high-density weights can be used.)

b. Obtain base support fixture XEOR923022 and support test fixture XEOR923024, or equivalents.

c. Obtain platform 9027211 and base 9027219 from shelf 3 of Engine Components Installer G4071.

d. Attach base to base support fixture. Torque bolts to 90-120 inch-pounds.

CAUTION

In the following procedure, the base support fixture can move laterally when the proof-test weight is applied, causing the platform to fall, resulting in damage to equipment.

e. Restrain base support fixture to prevent lateral movement.

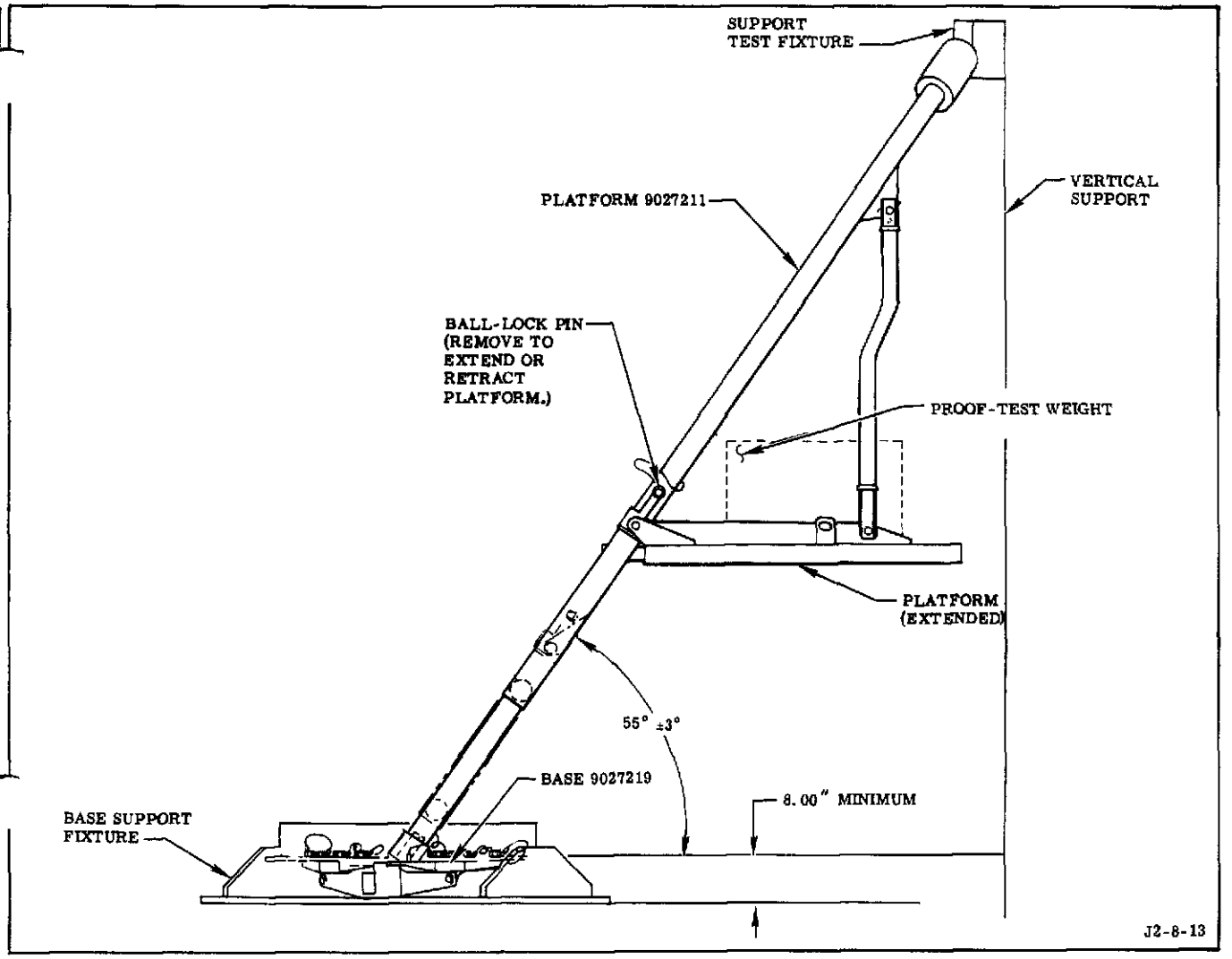

Figure 4-18. Proof-Test Setup for Engine Internal Access Platform

f. Position platform as shown in figure 4-18.

g. Place proof load on platform for 3 minutes.

h. Remove proof load and inspect platform for signs of structural damage and permanent deformation.

i. Disassemble proof-test setup, returning acceptable proof-test parts to their respective storage locations. (Refer to section I.)

4-34. PROOF-TESTING FUEL EXHAUST DUCT HANDLER 9025874. The handler may be proof tested subsequent to track and hoist proof-testing (paragraph 4-31) using the hoist as a holding ture.

a. Obtain a holding fixture (figure 4-19, or equivalent) and a 150 ±7.5 pound proof-test weight that meets the requirements of figure 4-20. The hoist mounted on a stable track configuration may be used as the holding fixture.

b. Attach handler to hoist or test fixture. Attitude of handler is to be equivalent to position 1 in figure 4-20.

c. Attach proof-test weight to handler.

d. Cautiously raise proof-test weight and suspend for 3 minutes. Do not raise weight more than necessary to clear floor.

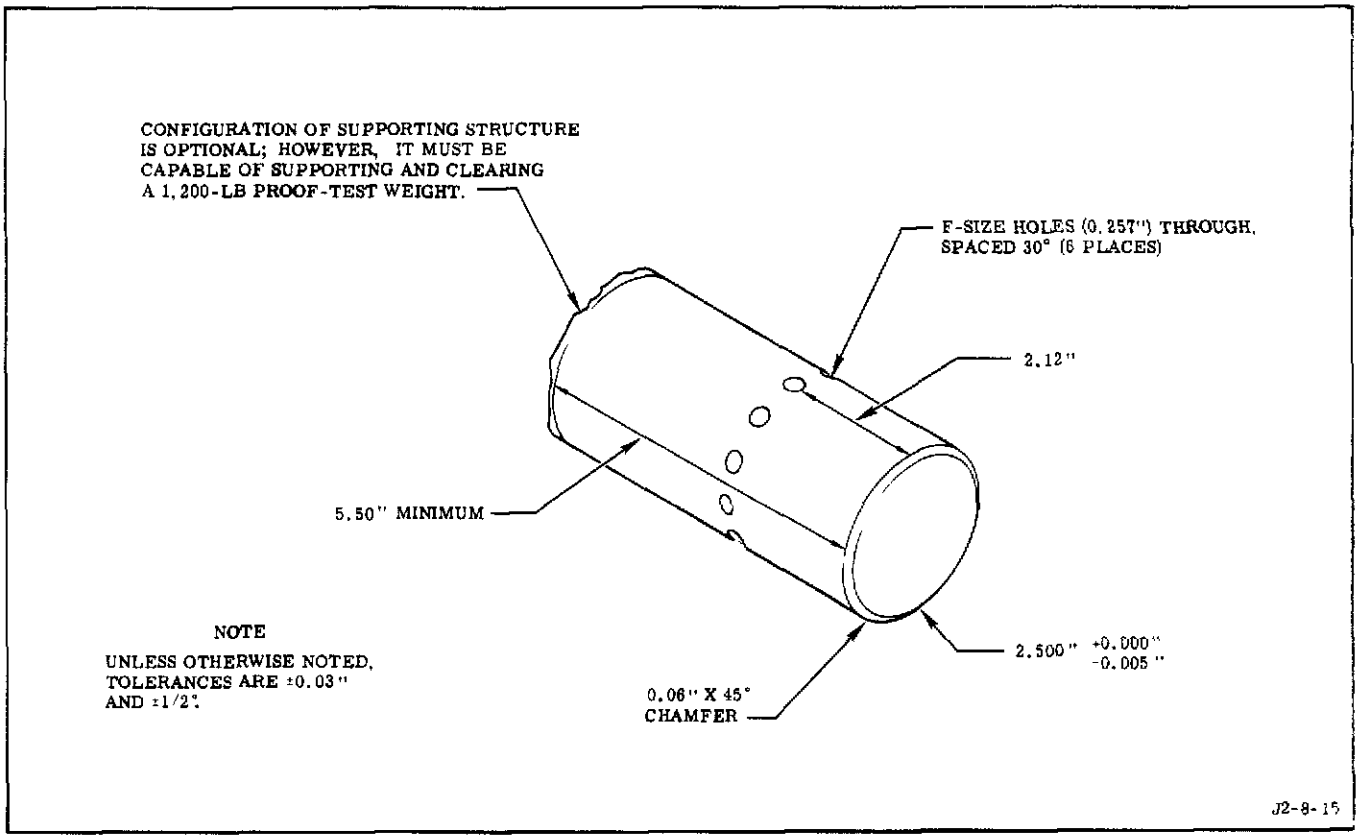
CONFIGURATION OF SUPPORTING STRUCTURE IS OPTIONAL; HOWEVER, IT MUST BE CAPABLE OF SUPPORTING AND CLEARING A 1,200-LB PROOF-TEST WEIGHT.
F-SIZE HOLES (0.257") THROUGH, SPACED 30° (6 PLACES)
2.12"
5.50" MINIMUM
2.500" +0.000" -0.005"
0.06" X 45° CHAMFER
NOTE
UNLESS OTHERWISE NOTED, TOLERANCES ARE ±0.03" AND ±1/2°.
J2-8-15

Figure 4-19. Proof-Test Fixture Adapter

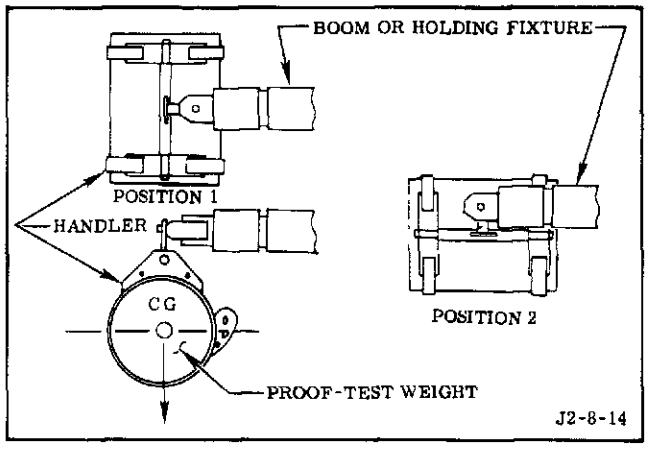

Figure 4-20. Proof-Test Setup for Fuel Exhaust Duct Handler

e. Rotate handler from position 1 to position 2 (figure 4-20) with proof load applied. Suspend for 3 minutes; then remove proof-test weight.

f. Inspect handler for signs of structural damage or permanent deformation.

g. Disassemble proof-test setup. Return acceptably proof-tested handler to its respective storage location on stowage cart. Refer to section I for storage location.

4-35. PROOF-TESTING PRIMARY AND AUXILIARY FLIGHT INSTRUMENTATION PACKAGE HANDLERS 9026942 and 9027225. The handler may be proof-tested subsequent to track and hoist proof-testing (paragraph 4-31) using the hoist as a holding fixture.

NOTE

This procedure is applicable to either the primary or auxiliary flight instrumentation package handler.

a. Obtain a holding fixture (figure 4-19, or equivalent) and a 66 ±3 pound (proof load for primary package) and a 60 ±3 pound (proof load for auxiliary package) proof-test weight which meet the requirements of figure 4-21. The hoist mounted on a stable track configuration may be used as the holding fixture.

b. Attach the applicable proof-test weight to the handler to be tested.

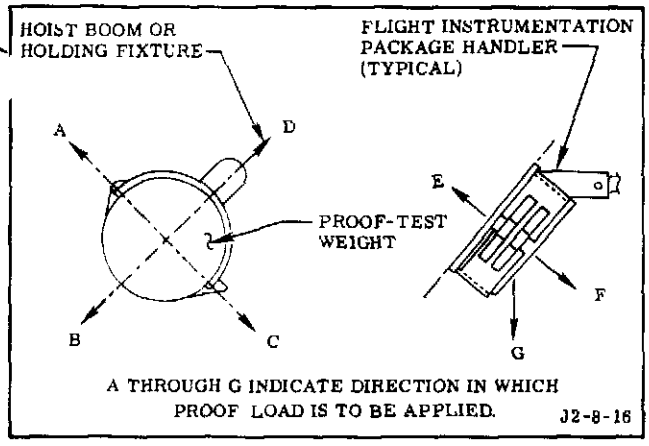

Figure 4-21. Flight Instrumentation Package Handlers Proof-Test Diagram

c. Attach handler to holding fixture, securing handler so that proof load is applied in any one of the directions shown in figure 4-21. Rotate handler or holding fixture, as necessary, to control proof load direction.

d. Suspend handler with proof-test weight for a minimum of 3 minutes.

e. Repeat steps c and d for remaining posions shown in figure 4-21.

f. Remove proof-test weight and inspect handler for signs of structural damage or permanent deformation.

4-36. PROOF-TESTING LOX AND FUEL TURBOPUMP HANDLER 9026977. Proof-test handler by suspending an 880 ±20 pound proof-test weight from handler for a minimum of 3 minutes. The cg of the proof-test weight must be within 1/2-inch of the center of the turbopump handler. The handler lifting eye must be to the ℄ CHAIN FUEL T/P position during the proof test. After removal of proof-test weight, inspect handler for signs of structural damage or permanent deformation. This turbopump handler can be proof tested in conjunction with turbopump handler adapter 9026997 (paragraph 4-56) by assembling the adapter to the handler and suspending the proof-test weight for an additional 3-minute period utilizing the adapter stud positioned to FUEL T/P PICKUP position.

4-37. PROOF-TESTING ENGINE COMPONENT HANDLING ANGLE ADAPTER 9027172. The ngle adapter may be proof tested subsequent track and hoist proof testing (paragraph 4-31) using the hoist as a holding fixture.

a. Obtain the following test equipment:

(1) A 300 ±15 pound test weight

(2) A holding fixture (figure 4-19, or equivalent) (The hoist mounted on a stable track configuration may be used as the holding fixture.)

(3) An extension, to suspend proof-test weight 13.31 inches from face of angle adapter (figure 4-22) (Gimbal and injector handler extension 9027266 may be used.)

b. Install and position angle adapter on boom or test fixture as shown in figure 4-22.

c. Install extension on angle adapter and attach proof-test weight to extension, to dimension shown in figure 4-22.

d. Suspend proof-test weight from adapter for a minimum of 3 minutes.

e. Remove weight, and inspect angle adapter for signs of structural damage or permanent deformation.

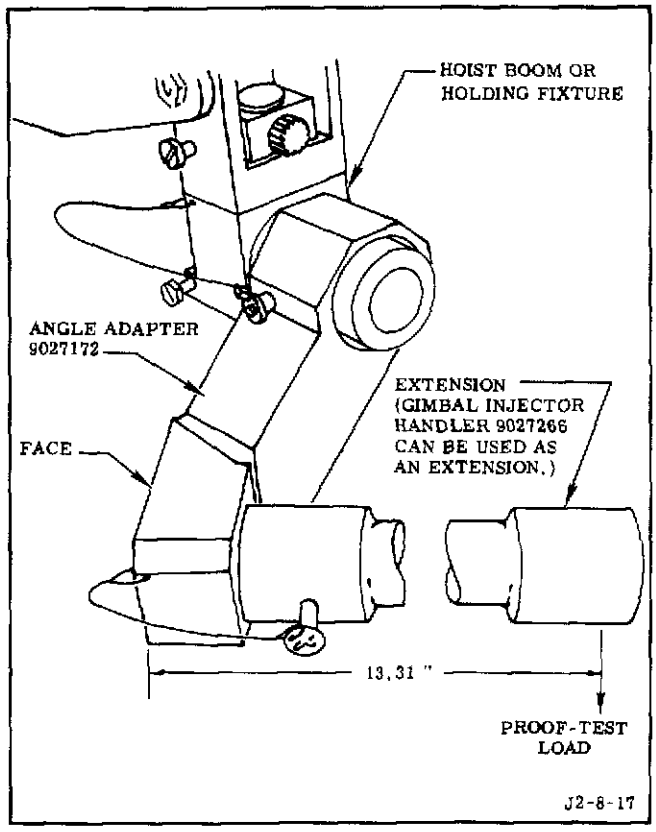

Figure 4-22. Proof-Test Setup for Engine Component Handling Angle Adapter

4-38. PROOF-TESTING COMPONENT HANDLER ADAPTER 9027174.

a. Obtain a holding fixture (figure 4-19, or equivalent) and a 1,120 ±2.5 pound proof-test weight.

b. Attach handler adapter to holding fixture in attitude shown in figure 3-2, view F.

c. Suspend proof-test weight so that cg of weight is in line (within 1/4-inch) with vertical holes on small end of adapter.

d. Maintain proof-test weight suspended for a minimum of 3 minutes, then remove proof-test weight.

e. Rotate adapter 90 degrees clockwise, and secure adapter to holding fixture. Clockwise direction is determined facing holding fixture and will rotate angled portion upward.

f. Repeat steps c and d, except aline (within 1/4-inch) cg of weight with horizontal holes on small end of adapter.

g. Inspect handler adapter for signs of structural damage or permanent deformation.

4-39. PROOF-TESTING TRACK SUPPORT STRUTS 9027178 and 9027178-11. Proof-test struts by applying a tension load or suspending a proof-test weight of 2,000 ±50 pounds for a minimum of 3 minutes on each strut. Struts are to be extended to their maximum length during proof testing. Remove proof load and inspect strut assemblies for signs of structural damage or permanent deformation.

4-40. PROOF-TESTING TRACK SUPPORT BRACKETS 9027182, 9027182-11, and 9027182-21.

a. Obtain a proof-test fixture or fixtures which simulate the configuration of the stage structure to which the brackets attach, and one or two 2,000 ±50 pound proof-test weights. As an aid in determining configuration of stage structure, see figure 2-4 for attach locations of the brackets.

NOTE

Each bracket contains two eyebolts from which the proof-test weights are to be suspended. Proof load may be suspended individually requiring one proof-test weight or simultaneously requiring 2 proof-test weights.

b. Attach bracket to proof-test fixture. Torque bolts to 100 ±10 inch-pounds. Make sure that rubber pad on clamp is bearing full on proof-test fixture.

c. Suspend proof-test weight for a minimum of 3 minutes from each eyebolt.

d. Remove proof-test weight and inspect brackets for signs of structural failure and permanent damage.

4-41. PROOF-TESTING TRACK SUPPORT PLATFORM 9027190.

NOTE

The requirements of this paragraph constitute only partial proof-test requirements for the platform. To be fully proof tested, the requirements of this paragraph and paragraph 4-30 (as pertains to track configuration number 2 only) must be met.

Proof-test the platform by applying vertical loads of 500 ±15 pounds to each of the 2 inboard eyebolts and 2,000 ±40 pounds to each of the outboard eyebolts for a minimum of 3 minutes on each eyebolt. Loads may be applied simultaneously to the 2 inboard eyebolts, but must be applied individually to the 2 outboard eyebolts. Counter proof loads by applying a restraining load on the entire surface of the platform, to within 8 inches maximum of each eyebolt. Upon completion of proof test, inspect platform for signs of structural damage or permanent deformation.

NOTE

The 2 eyebolts mounted approximately 12-1/2 inches apart are the inboard eyebolts.

4-42. PROOF-TESTING PLATFORM POSITIONING CABLE 9027184. Proof-test cable by applying a tension load of 400 -20 pounds for a minimum of 3 minutes. Apply load to cable through ball-lock pin at jaw end of turnbuckle and 2 x 3 inch plate at opposite end. Turnbuckle must be extended to where only 1 to 3 threads are showing inside barrel at each end. Upon

completion of proof test, remove proof load and inspect positioning cable for structural damage or permanent deformation.

4-43. PROOF-TESTING HEAT SHIELD SUPPORT TURNBUCKLE 9027185. Proof-test heat shield support turnbuckle as shown in figure 4-23 for a minimum of 3 minutes. Turnbuckle must be fully extended during test. Upon completion of proof-test, remove proof load and inspect heat shield support turnbuckle for structural damage or permanent deformation.

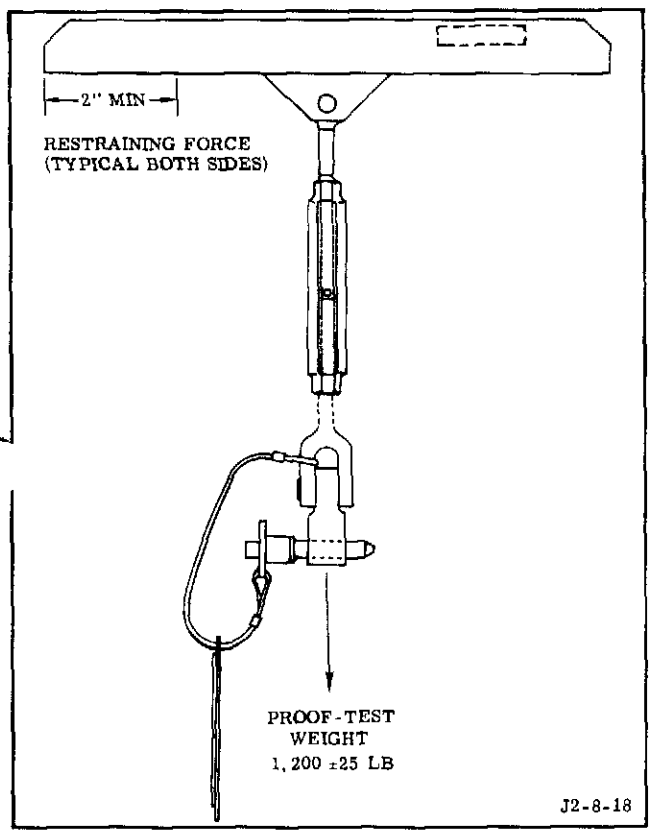

Figure 4-23. Proof-Test Setup for Heat Shield Support Turnbuckle

4-44. PROOF-TESTING START TANK HANDLER 9026189. The start tank handler may be proof tested subsequent to track and hoist proof testing (paragraph 4-30 or 4-53), using the hoist as a holding fixture.

a. Obtain the following test equipment:

(1) 200 ±10 pound test weight. Weight must meet requirements shown in figure 4-24. A J-2 engine start tank ballasted with sand or a quid, or similar substance, will meet the requirements of figure 4-24.

(2) Holding fixture (figure 4-19, or equivalent) (The hoist mounted on a stable track configuration may be used as the holding fixture.)

b. Attach handler and proof-test weight to meet requirements of figure 4-24.

c. Proof-test handler for a minimum of 3 minutes.

d. Remove proof-test weight, and inspect handler for signs of structural damage and permanent deformation.

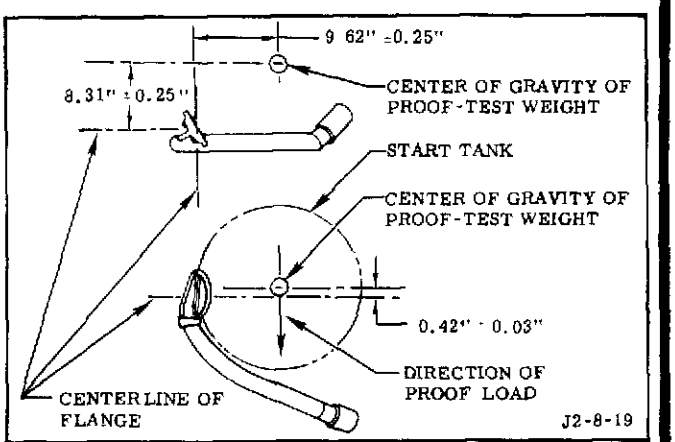

Figure 4-24. Proof-Test Setup for Start Tank Handler

4-45. PROOF-TESTING GIMBAL AND INJECTOR HANDLER 9027263.

a. Obtain a 600 ±30 pound proof-test weight and a holding fixture (figure 4-19, or equivalent).

b. Set gimbal and injector handler to its maximum extended position.

c. Secure gimbal and injector handler to holding fixture with yoke end of handler horizontal and surface with slide plate, up.

d. Apply proof-test weight so that cg of weight is 5.68 ±0.125 inches from open end of yoke.

e. Maintain proof load for a minimum of 3 minutes.

f. Remove weight and inspect handler for signs of structural damage or permanent deformation.

4-46. PROOF-TESTING SLINGS AND STRAPS.

a. Apply a 1,120 ±20 pound load to the following slings or straps for a minimum of 3 minutes:

NOTE

The surfaces of any device, used to apply or restrain the proof load, that come into direct contact with the sling must have minimum radii of 1/2 inch.

(1) 6001-5-3

(2) 6001-5-4

(3) 6001-5-5

(4) NAS1213R10J36

(5) NAS1213R10J48

b. Remove proof-test load.

c. Inspect slings for signs of failure or deformation.

NOTE

Sling 6001-5-25 may be proof tested in conjunction with winch-hoist 2250-38M-3S.

d. Apply a 1,600 ±40 pound load to sling 6001-5-25 for a minimum of 3 minutes. Repeat steps b and c.

NOTE

The surfaces of any device used to apply or restrain the proof load, that come into direct contact with the sling must have minimum radii of 1/2 inch.

4-47. PROOF-TESTING ENGINE COMPONENT HANDLER 9024539. Proof-test component handler by suspending a 700 ±25 pound proof load from the 2 outermost bolts for a minimum of 3 minutes. The handler is to be supported by the eyebolt and to be within 10 degrees of horizontal during test. There must be no structural damage or permanent deformation.

4-48. PROOF-TESTING ENGINE COMPONENT HANGER 9024543. Proof-test hanger by suspending a 1,200 ±50 proof load from attach point at top of hanger. Secure proof load with pin attached to hanger. Hanger must be erected and on a level work surface. Maintain proof load for a minimum of 3 minutes. There must be no structural damage or permanent deformation.

4-49. PROOF-TESTING ENGINE COMPONENT PICKUP ADAPTER 9024547. Proof-test pickup adapter by suspending a 1,120 ±25 pound proof load from lower attach point on adapter. Secure proof load with pin attached to adapter. The adapter must be supported by the swivel eye. Maintain proof load for a minimum of 3 minutes. There must be no structural damage or permanent deformation.

4-50. PROOF-TESTING INSTALLER SLING CABLE 9026256. Proof-test installer sling by loading each leg to 6,520 ±100 pounds. Maintain proof load for a minimum of 3 minutes on each leg. There must be no failure of cable strands or permanent deformation of lift ring or hooks. An alternate method of proof-testing the installer sling is to use the cable when proof-testing stowage cart 9025965. (Refer to paragraph 4-59.)

4-51. PROOF-TESTING WINCH-HOIST 2250-38M-3S. Proof-test the winch to 1,600 ±40 pounds. Observe the following:

NOTE

Proof test of the winch hoist can be done in conjunction with sling 6001-5-25.

a. Proof-test the winch with cable arranged to effect a compound lift (i.e., hook on end of cable hooked into body of winch).

b. With proof load applied, extend winch cable until 1 to 1-1/2 cable wraps remain on drum; then retract cable a minimum of one turn.

c. At conclusion of proof test, inspect winch. There must be no structural failure, damage to cable, or permanent deformation to any part of the winch.

4-52. PROOF-TESTING ENGINE COMPONENT HANDLING HOIST 9027095.

a. Obtain a holding fixture (figure 4-19, or equivalent) and a 1,120 ±20 pound proof-test weight.

b. Secure winch hoist to holding fixture.

c. Extend chain until chain is within 6 links of being fully extended.

d. Apply proof load to end of chain for a minimum of 3 minutes.

e. Inspect hoist for signs of structural damage or permanent deformation.

4-53. PROOF-TESTING TRACK AND HOIST G4072. This task requires a level concrete working area, a minimum 22 feet square, serviced by an overhead hoist or forklift capable of lifting 1,120 pounds.

a. Obtain the following tools and equipment:

(1) A 3-1/2-inch spanner wrench No. 462 (J.H. Williams and Co), or equivalent.

(2) A 1,120 ±20 pound proof-test weight, capable of being attached to end of boom 9027051 and not exceed 13 inches in height from centerline of attach hole.

NOTE

Proof-test procedures require the proof load to be suspended over the track with the boom horizontal or near horizontal. A proof-test weight that exceeds 13 inches in height from the centerline of the attach hole may not clear the track.

b. Obtain Engine Components Installer G4072 parts listed in figure 4-25.

Nomenclature	Part Number	Number Required (One Unless Noted)	Shelf Number
Extension	9027080		5
Track section	9027162		4
Track section	9027163		4
Track section	9027163-11		4
Track section	9027163-21		4
Track section	9027163-31		4
Track section	9027163-41		4
Stop	9027156	2	4
Hook	9024600		3
Sleeve	9027084		3
Sleeve	9027084-11		3
Base	9027164	8	2
Boom	9027051		2
Turntable	9027101		2
Track pin	9027160	7	1
Support pin	9027161	8	1
Extension	9027196	8	1

Figure 4-25. G4072 Parts Required for Proof-Testing Track and Hoist

c. Assemble track configuration in accordance with figure 4-26, observing the following requirements:

(1) Before mating, make sure track ends (plugs and adapters) are clean and free of burs or damage that could impair mating of the track sections.

CAUTION

Mating portions of track sections are close tolerance fits. Dirt or damage could prevent assembly or make disassembly difficult.

(2) Mate track sections carefully, preventing damage to contacting surfaces (figure 4-3).

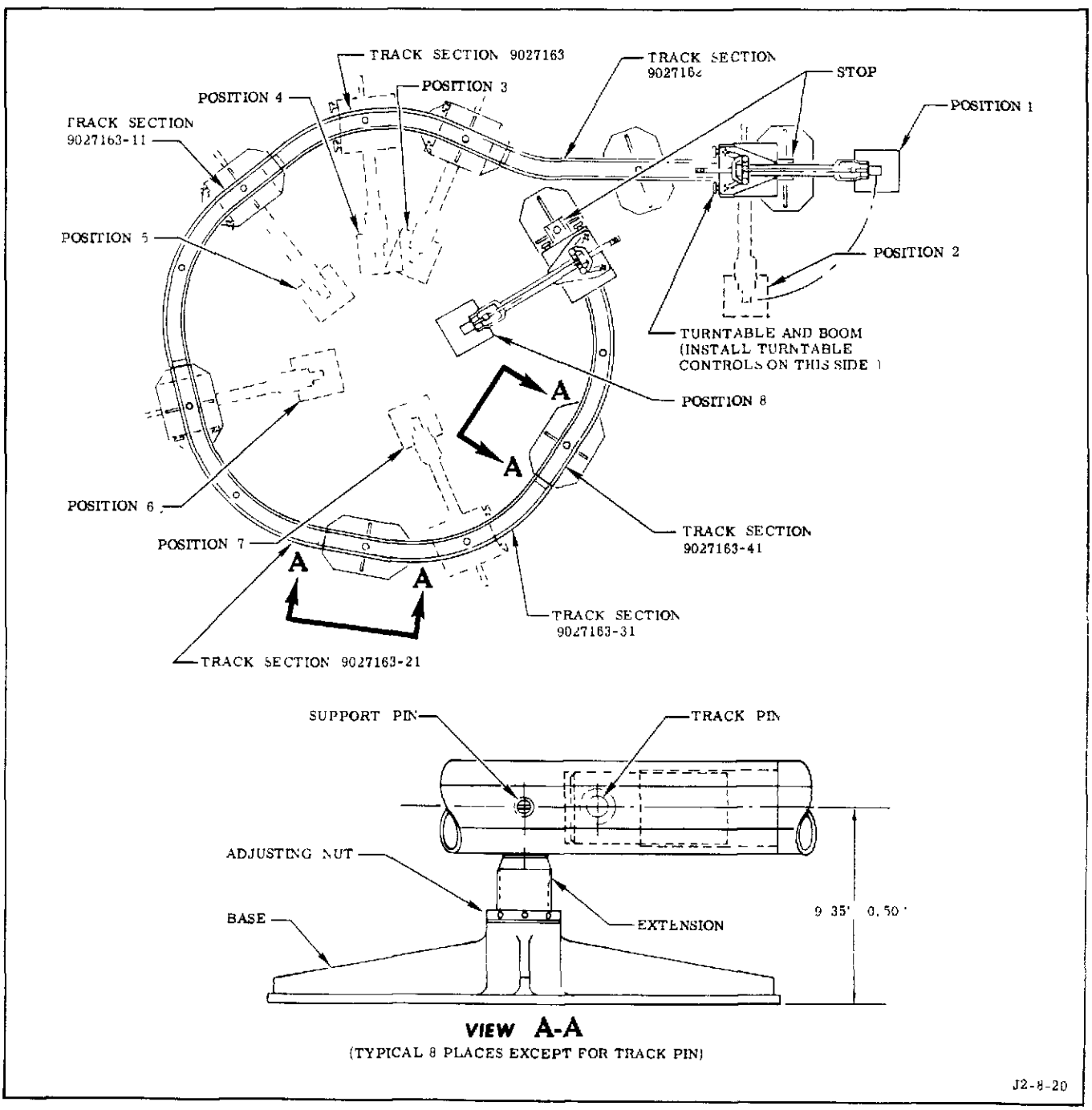

Figure 4-26. Track Configuration and Proof-Test Positions (G4072)

(3) Secure each extension to track or stops with a support pin. Tighten support pins sufficiently to seat head of pin.

(4) Secure each mated track joint with a track pin. Make sure track pins do not protrude beyond outer surfaces of track.

(5) Install turntable on track, with controls positioned as noted in figure 4-26, before installing last stop. If in doubt as to how turntable installs, see figure 4-4 for an installed view. Brake handle must be inboard (brake off) when installing turntable.

(6) Adjust height of track by rotating extension adjusting nuts with spanner wrench. If nut is difficult to rotate, lubricate threads with Molykote G paste (Dow Corning Corp).

(7) Check rail alinement at each track joint. Misalinement must not exceed 0.010 inch. (See figure 4-9.) Adjust extensions as necessary to aline, maintaining track elevation within required height.

NOTE

Misalinement of rails exceeding wheel-to-track clearance can prevent movement of hoist over track joint.

(8) Hand-tighten bolts that secure boom to turntable.

(9) Secure hook-to-boom socket with hook latch arm on top and vertical.

WARNING

The following task subjects the equipment to extreme loads. Failure of a part under load could cause part to whip or be projected at velocities that can cause injury or death.

d. Proof-test by suspending the proof-test weight for a minimum of 3 minutes, at each of the positions identified in figure 4-26. Sequence is optional. The following requirements must be complied with:

(1) Only those persons necessary for the performance of this task should be allowed in the immediate vicinity.

(2) Use overhead hoist or forklift to connect proof-test weight to boom.

CAUTION

In the following procedure, raising boom with proof load applied will cause pin in boom drive adapter to shear.

(3) Prior to applying proof-test weight, position boom above horizontal so that when proof load is applied, boom will not deflect below horizontal. If boom does deflect below horizontal, remove proof load and reposition boom higher. Do not raise boom with proof load applied. If boom remains above horizontal with proof load applied, lower it to near horizontal with the boom controls.

(4) When changing positions which require moving hoist along track, remove proof load from hoist before moving hoist.

(5) Turntable brack must be applied at all times, except when hoist is being installed or moved along track.

(6) When proof-test position requires load to be suspended to side of track, turntable must be positioned laterally, full toward side of track load is suspended from. Lateral position of turntable must be accomplished prior to applying proof load to hoist.

CAUTION

In the following procedure, rotating proof load in arc other than shown in figure 4-26 can cause an unstable condition where the proof load could overbalance the track and cause the track to lift off the ground.

(7) When proof-test position requires proof load to be rotated from side to over the track, or vice versa, turntable must be positioned laterally, full toward side of track, load is rotated from or to. Lateral position of turntable must be accomplished prior to applying proof load to hoist. Rotate proof load only in arc shown.

e. When proof load has been applied to all positions shown in figure 4-26, remove proof load and visually inspect components for signs of structural damage or permanent deformation.

f. Prior to disassembling (step g), the hoist as presently mounted may be used as a holding fixture to proof-test parts whose proof-test weight does not exceed the 600 pound or 23,000 inch-pound working capacity of the hoist. The following parts can be proof tested using the hoist as a holding fixture:

(1) Fuel turbine exhaust duct handler 9025874

(2) Start tank handler 9026189

(3) Primary flight instrumentation package handler 9026942

(4) Component handling angle adapter 9027122

(5) Auxiliary flight instrumentation package handler 9027225

g. Disassemble proof-test setup. Return acceptable proof-tested parts of G4072 to their respective locations on stowage cart. See figure 4-25, or section I for shelf numbers, parts are stored on.

4-54. PROOF-TESTING ELEVATED TRACK. This task requires a level concrete working area a minimum of 22 feet square, serviced by an overhead hoist or forklift capable of lifting 1,120 pounds.

a. Obtain the following tools and equipment:

(1) A 3-1/2-inch spanner wrench No. 462 (J. A. Williams and Co), or equivalent

(2) A 1,120 ±20 pound proof-test weight, capable of being attached to end of boom 9027051

(3) Supports for end of track and a 2,500 pound minimum counterbalance as shown in figure 4-27

b. Obtain engine components installer set 9026252 parts and Engine Components Installer G4072 parts listed in figure 4-28.

c. Assemble either elevated track configuration in accordance with figure 4-27 observing the following:

NOTE

Both track configurations require proof testing; however, since common parts are used in each configuration, only one can be assembled at a time. It is optional as to which configuration is assembled first.

(1) Before mating, make sure track and stops are clean and free of burs or damage that could impair mating of the track sections.

CAUTION

Mating portions of the track section and stops are close tolerance fits. Dirt or damage could prevent assembly or make disassembly difficult.

(2) Mate track section and stops carefully to prevent damage to contacting surfaces (figure 4-3).

(3) Secure support and extensions 9027196 to stop and track with a support pin. Tighten support pins sufficiently to seat head of pin.

(4) Secure stops to track with a track pin. Make sure track pins do not protrude beyond outer surfaces of track.

(5) Install turntable on track before installing last stop. If in doubt as to how turntable installs, see figure 4-4 for an installed view. Direction of turntable controls is optional.

(6) Adjust height of track by rotating extension adjusting nuts with spanner wrench. If nut is difficult to rotate, lubricate threads with Molykote G past (Dow Corning Corp).

(7) Hand-tighten bolts securing boom to turntable.

(8) Secure hook-to-boom socket with hook latch arm on top and vertical.

WARNING

This task subjects the equipment to extreme loads. Failure of a part under load could cause part to whip or be projected at velocities that can cause injury or death.

d. Proof-test by suspending the proof-test weight for a minimum of one minute at each of the positions identified in figure 4-27. The following requirements must be complied with

NOTE

Whichever configuration is assembled first, must be proof tested in all three positions. Whichever configuration is assembled second, must be proof tested in position 1 only.

(1) Only those persons necessary for the performance of this task should be allowed in the immediate vicinity.

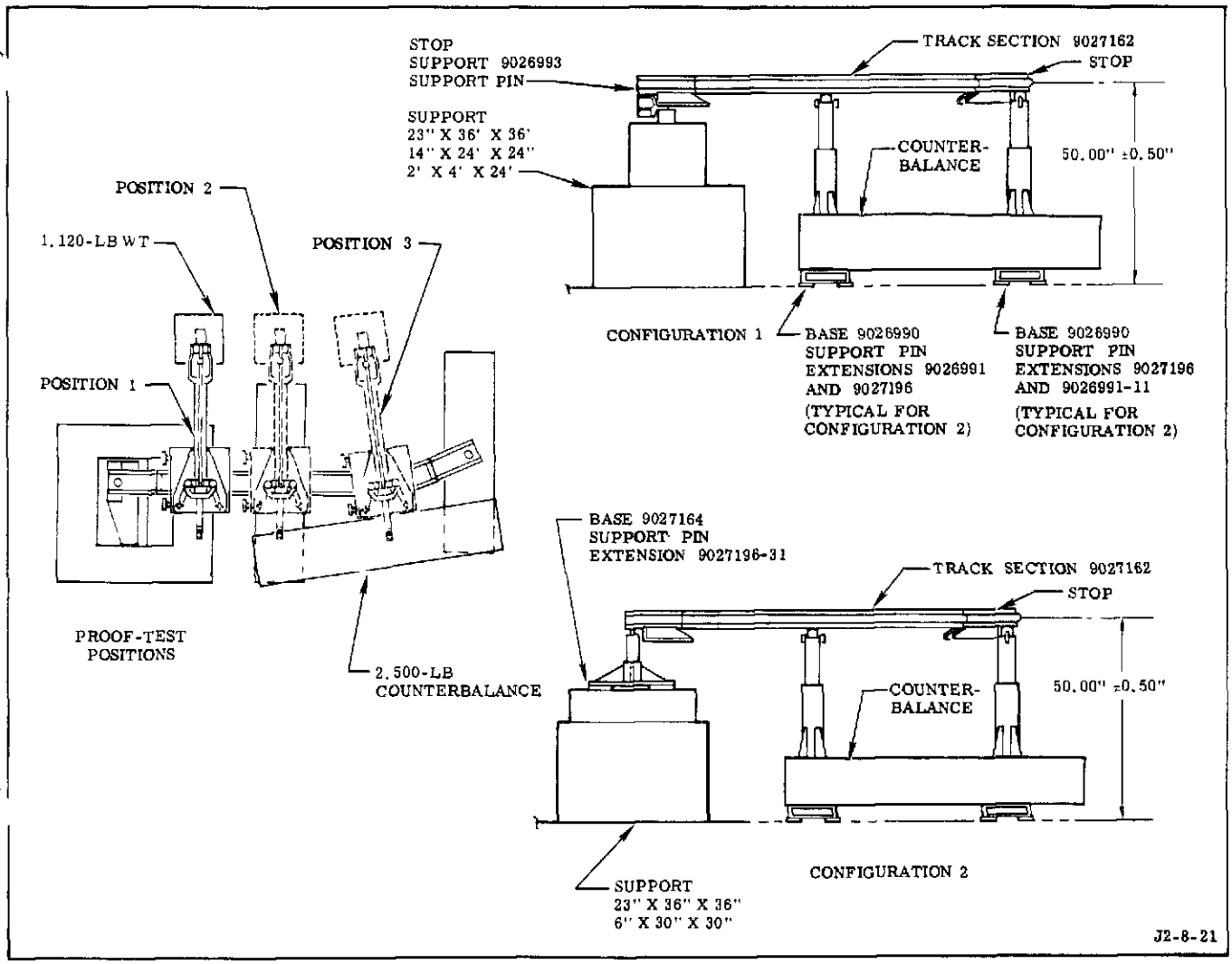

Figure 4-27. Proof-Test Setup for Elevated Track

(2) Use overhead hoist or fork lift to connect proof-test weight to boom.

CAUTION

In the following procedure, raising boom with proof-load applied will cause pin in boom driver adapter to shear.

(3) Prior to applying proof-test weight, position hoist boom above horizontal so that when proof load is applied, boom will not deflect below horizontal. If boom does deflect below horizontal, remove proof load and reposition boom higher. Do not raise boom with proof load applied. If boom remains above horizontal with proof load applied, lower it to near horizontal with the boom controls.

(4) When changing position, which requires moving hoist along track, remove proof load from hoist before moving hoist.

(5) Turntable brake must be applied at all times, except when hoist is being installed or moved along track.

e. When proof load has been applied to the 3 proof-test positions, remove proof load and visually inspect components for signs of structural damage or permanent deformation.

f. Repeat steps c through e for untested configuration, except it is necessary only to repeat proof-test position number 1.

g. Prior to disassembling (step h), the hoist as presently mounted may be used as a holding fixture to proof-test parts whose proof-test weight does not exceed the 600 or 23,000 inch-pound working capacity of the hoist. The following parts can be proof-tested using the hoist as a holding fixture:

(1) Fuel turbine exhaust duct handler 9025874

(2) Start tank handler 9026189

(3) Primary flight instrumentation package handler 9026942

(4) Component handling angle adapter 9027122

(5) Auxiliary flight instrumentation package handler 9027225

h. Disassemble proof-test setup. Return G4072 parts to their respective locations on stowage cart. See figure 4-28, or section I for shelf numbers, parts are stored on.

4-55. PROOF-TESTING ACCESS WORK PLATFORM.

a. Obtain the following equipment:

(1) Frame 9024598-1

(2) Frame 9024598-2

(3) Platform 9025848

b. Obtain a 400 ± 8 pound proof-test weight. The proof-test weight must have a minimum bearing area of one square foot and not exceed 13 inches on any side of the bearing area.

NOTE

The proof-test weight will be applied to the hinged platform, which measures approximately 13 inches square.

c. Assemble work platform assembly and place on raised support. (See figure 4-29.) A forklift can be used as the support.

d. Place proof-test weight in position one (figure 4-29) for a minimum of 3 minutes.

e. Remove proof-test weight and inspect work platform assembly for signs of structural damage and permanent deformation.

Nomenclature[a]	Part Number	Number Required (One Unless Noted)	Shelf Number[b]
Base	9026990	2	
Extension	9026991		
Extension	9026991-11		
Support	9026993		
Stop	9027156		
Support pin	9027161		
Extension	9027196-31		
Track section[c]	9027162		4
Stop[c]	9027156		4
Base[c]	9027164		2
Hook[c]	9024600		3
Boom[c]	9027051		2
Turntable[c]	9027101		2
Track pin[c]	9027160	2	1
Extension[c]	9027196	2	1
Support pin[c]	9027161	2	1

(a) Part of components installer set 9026252, unless otherwise noted
(b) Applicable only for G4072 parts
(c) Part of Engine Components Installer G4072

Figure 4-28. Parts Required for Proof-Testing Elevated Track

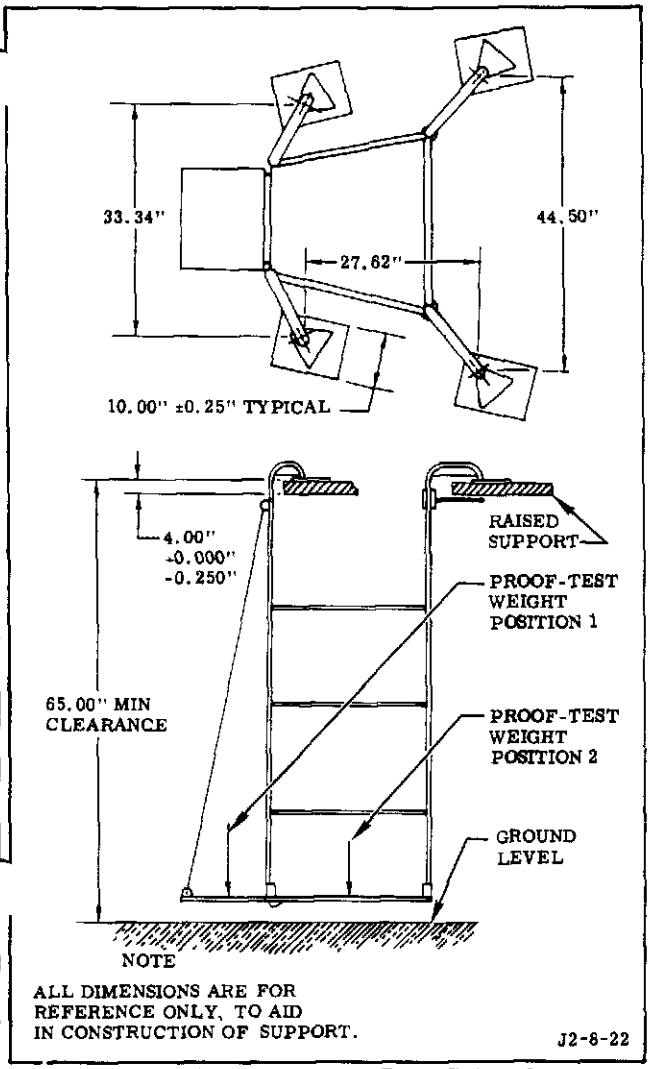

Figure 4-29. Proof-Test Setup for Work Platform

f. Place proof-test weight in position two (figure 4-29) for a minimum of 3 minutes.

g. Remove proof-test weight and inspect work platform assembly for signs of structural damage and permanent deformation.

4-56. PROOF-TESTING TURBOPUMP HANDLER ADAPTER 9026997. Proof-test by suspending an 880 ±20 pound proof-test weight from the handler adapter for a minimum of 3 minutes. The cg of the proof-test weight must be within 1/2-inch of the center of the turbopump handler. The handler lifting stud must be in the FUEL T/P PICKUP position during the proof test. After removal of proof-test weight, inspect handler for signs of structural damage or permanent deformation. This handler adapter can be tested in conjunction with turbopump handler 9026977 (paragraph 4-36) by assembling the adapter to the handler and suspending the proof-test weight for an additional 3-minute period, utilizing the handler lifting eye positioned to ℄ CHAIN FUEL T/P.

4-57. PROOF-TESTING ENGINE COMPONENT ADAPTER 9027170 AND PIN 9027169. This task consists of suspending a 1,120 ±25 pound proof-test weight from the pin attached to adapter holes B and C, for a minimum of 3 minutes in each position. Attach adapter to a holding fixture (figure 4-19, or equivalent). Remove proof-test weight, and inspect pin and adapter for signs of structural damage or permanent deformation.

4-58. PROOF-TESTING ENGINE LOWERING SYSTEM (G4072). This task requires a working area serviced by an overhead hoist having a minimum capacity of 8,000 pounds.

a. Obtain the following tools and equipment:

(1) Vertical installer and engine sling proof-test weight 9025145, or equivalent. Hoist assembly 9026679 (part of the proof-test weight) is not required for this task.

(2) Adapters EWR828272-1 and EWR828272-2, or equivalent

(3) Engine lowering fixture XEOR923020, or equivalent

(4) Torque wrenches capable of torquing 330-430, 520-680, and 1,140-1,260 inch-pounds

(5) Six-inch level

b. Obtain Engine Components Installer G4072 parts listed in figure 4-30.

c. Position proof-test weight in area serviced by overhead hoist.

d. Attach engine lowering fixture to hoist.

Nomenclature	Part Number	Number Required (One Unless Noted)	Shelf Number
Frame	9027254-1		2
Frame	9027254-2		2
Turnbuckle(a)	9027226-1		2
Bracket(a)	9027232		2
Bracket	9027231		2
Bolt(b)	9027227		2
Bracket	9027257		2
Beam	9027258-2		2
Beam	9027258-1		2
Turnbuckle	9027226-2		2

(a) Stored assembled
(b) Captive in bracket 9027231

Figure 4-30. G4072 Parts Required for Proof-Testing Engine Lowering System

e. Assemble engine lowering system, attaching it to lowering fixture XEOR923020 and to proof-test weight. (See figure 4-31.) Observe the following:

(1) Maintain engine lowering fixture level while attaching engine lowering system. This can be accomplished by using an auxiliary hoist.

NOTE

Assembly of the lowering system is difficult with the lowering fixture at an angle.

CAUTION

The lowering fixture is heavy. Swinging or other movement could impart sufficient side loads to damage the turnbuckles.

(2) Prevent swinging or movement of lowering fixture that could result in side loads on turnbuckles.

(3) Install turnbuckles in beams before attaching beams to frames. Install turnbuckles by inserting lower end of turnbuckle through beam (figure 4-14) and engaging upper adjusting mechanism to studs in beam. Prior to installing turnbuckles, rod end must be positioned fully to side as shown in figure 4-14.

(4) When attaching beams to frames, rotate beams so that adjustments at top of turnbuckle are toward operator.

(5) Turnbuckles must be fully extended when attached to proof weight.

(6) Turnbuckle rod-end must be positioned to dimension shown in figure 3-26.

f. Double-check assembly. All quick-disconnect pins must be fully inserted, bolts seated and torqued, and turnbuckles extended to their maximum length.

g. Raise hoist sufficiently to remove slack in lowering system; then, with level, check that turnbuckles are vertical. Adjust turnbuckles to vertical by use of adjustments at top of turnbuckles and/or repositioning hoist.

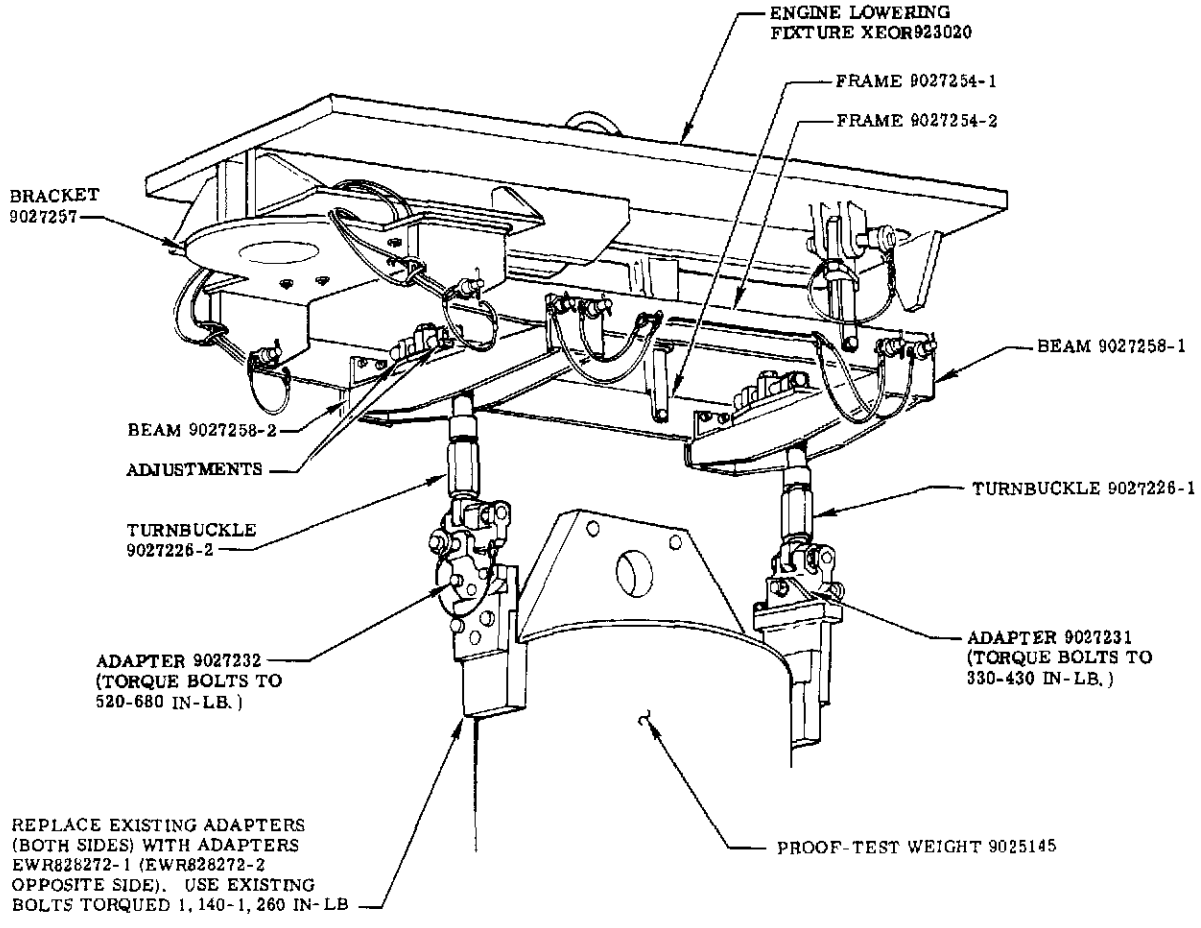

Figure 4-31. Proof-Test Setup for Engine Lowering System (G4072)

WARNING

Adjusting the lower end of the turnbuckles other than as shown in figure 3-26 can induce bending moments in the turnbuckles that will cause the turnbuckles to break, resulting in injury or death to personnel and damage to equipment.

h. Make sure lower end of turnbuckles is positioned to dimension shown in figure 3-26; then cautiously raise proof weight until suspended. Do not raise proof weight more than necessary to clear floor. It is not necessary that proof weight hang vertical.

i. Keep proof weight suspended for a minimum of 3 minutes: then lower it.

j. Visually inspect lowering system for signs of structural failure or permanent deformation.

k. Disassemble proof-test setup returning acceptable proof-tested parts of G4072 to their respective storage locations on storage cart. (See figure 4-30 and section I.)

4-59. PROOF-TESTING STOWAGE CART 9025865 AND 9025870. This task requires a level concrete working area, a minimum of 10 by 16 feet and serviced by an overhead hoist having a minimum capacity of 20,000 pounds (to proof-test stowage cart 9025865) or 15,000 pounds (to proof-test stowage cart 9025870). Proof-test requirements for cable 9026256 (paragraph 4-50) can be satisfied by using the cable to suspend stowage cart 9025865.

a. Obtain a sufficient number of proof-test weights to total 12,400 ±250 pounds (stowage

cart 9025865), or 7,200 ±144 pounds (stowage cart 9025870). Proof-test weights can be sand bags, lead weights, etc., however, they must be numerous and lightweight (30 to 50 pounds) to permit loads to be distributed uniformly on the shelves of the stowage cart.

b. Obtain a lift sling capable of being attached to the four lifting eyes on the stowage cart. Each leg of the sling must have a minimum breaking strength of 23,000 pounds and a minimum length of 106 inches. Cable 9026256 (paragraph 4-50) can be used to lift stowage cart 9025865 if cable is being proof tested concurrently with cart).

c. Remove all components stowed on cart.

d. Make sure all 4 lift rings are fully screwed into their respective bosses.

e. Using lifting sling, attach overhead hoist to stowage cart and aline hoist to cart.

f. Apply proof-test weights to shelves of stowage cart as listed in figure 4-32. Proof-test weights must be placed to provide as uniform loading as practical on each shelf.

NOTE

See applicable figure 1-1 or 1-2 for identification of shelf numbers.

- To prevent surface damage the plywood shelves of the stowage cart may be replaced for this task.

g. Using overhead hoist, raise stowage cart until cart is clear of floor and maintain cart suspended for a minimum of 3 minutes.

h. Remove proof-test weights, and visually inspect cart for signs of structural damage or permanent deformation.

4-60. PROOF-TESTING COVER 9027216. Proof-testing the cover consists of duplicating the installed condition of the cover and placing the proof load in the geometrical center of the installed cover.

a. Obtain a support that will keep cover clear of floor. Three pieces of wood 2 inches x 4 inches x 45 inches (or equivalent) will suffice.

Shelf	Stowage Cart 9025865 (Pounds)	Stowage Cart 9025870 (Pounds)
5	2,800 ±56	1,490 ±30
4	2,800 ±56	1,490 ±30
3	2,800 ±56	1,495 ±30
2	4,000 ±80	2,725 ±54

Figure 4-32. Distribution of Proof Load

b. Obtain a 500 ±15 pound proof-test weight. Area of proof-test weight surface that is to contact cover is to be 100-150 square inches.

c. Lay cover on supports so that one support is outboard of and adjacent to (within 2 inches) each of the 3 square tubular braces on underside of cover.

d. Lay proof weight on top of cover, within 3 inches of geometrical center of cover. Keep proof load applied a minimum of 3 minutes.

e. Visually inspect cover for signs of structural failure or permanent deformation.

4-61. PROOF-TESTING COMPONENT HANDLING CART 9026253. This task requires an overhead hoist having a minimum capacity of 1,500 pounds.

a. Obtain a 1,200 ±24 pound proof-test weight and cable 9026256 (or equivalent). Cable is part of engine components installer sets 9026251 or 9026252.

b. Using cable, attach overhead hoist to component cart and aline hoist to cart.

c. Place proof-load into center of cart and uniformly distribute over a minimum contact area of 20 square inches.

d. Using overhead hoist, raise cart until cart is clear of floor and maintain cart suspended for a minimum of 3 minutes.

e. Remove proof-test weight, and visually inspect cart for signs of structural damage or permanent deformation.

MANUAL DATA SUPPLEMENTS

Manual Data Supplements are issued from time to time to communicate important and urgent information concerning the equipment covered in this manual. These supplements bear an identifying number and should be filed in this Appendix.

Manual Data Supplements directly affect the data in this manual and will be incorporated into this manual during a future updating effort.

A Supplement Record is issued periodically to indicate the status of supplements issued for this manual. The status of each supplement is indicated in the "Supplement Status" column. For active Supplements, no status is entered. For incorporated supplements, "Incorporated" is entered.

Upon receipt of a Manual Data Supplement make an appropriate reference to the supplement in the margin next to the data supplemented and enter the number, date, and subject matter of the supplement on the Manual Data Supplement Record.

MANUAL DATA SUPPLEMENT RECORD

This Supplement Record indicates the status of supplements issued for Technical Manual R-3825-8. Supplements which have been incorporated into the manual shall be removed from the Appendix and destroyed.

Supplement Number	Dated	Description	Supplement Status
R-3825-8-1	6 March 1968	Incorporated MD1 change to Engine Components Installer G4071 and adds proof-testing requirements for the modified parts.	Incorporated
R-3825-8-2	10 April 1968	Corrects schedule numbers in weld schedule for inplace tube welding.	Canceled. (Weld schedule deleted.)
R-3825-8-3	22 May 1968	Adds requirements to make sure that electrical power is not applied to the engine when igniter cables or electrical connectors are disconnected from the electrical control assembly.	Incorporated
R-3825-8-4	6 June 1968	Adds installation and removal procedures for the G4072 track and hoist, internal access platform, and engine lowering system. Also adds installation and removal procedures for the engine gimbal and oxidizer and fuel inlet ducts.	Incorporated
R-3825-8-5	12 July 1968	Corrects torque value for bolts that secure the gimbal to the injector, from inch-pounds to foot-pounds.	Incorporated
R-3825-8-6	28 August 1968	Changes periodic requirement for proof testing, modifies the procedures for installing the lowering systems in the SII stage, modifies engine lowering and raising procedures, and adds requirement to install safety cables whenever engine lowering systems are used.	Incorporated

On page 3-167, paragraph 3-218, step h (last line), change torque value from 314-316 to 314-346.

On pages 3-178 and 3-179, replace paragraph 3-246 with the following:

3-246. The start tank support and fill valve (figure 3-45) may be replaced without affecting engine calibration.

WARNING

Removing start tank components before the system is depressurized and purged can result in serious injury to personnel and damage to equipment.

a. Depressurize start system, and make sure all fuel has been purged from system.

b. Make sure that all electrical power is removed from engine.

c. Remove support clamps as necessary to gain access and remove start tank support and fill valve. Note position of clamps for reinstallation.

d. If engine incorporates MD316, MD320, or MD351 change, cut start tank emergency vent line. (Refer to section VI.) Protect open lines with clean polyethylene and/or Aclar No. 33C film (Allied Chemical Corp) and tape.

e. Cut start tank initial fill line and pressure indicating line (TF1). (Refer to section VI.) Protect open lines with clean polyethylene and/or Aclar film and tape.

WARNING

Connecting or disconnecting electrical connectors without turning off electrical power can result in injury to personnel and damage to equipment.

f. If engine incorporates MD316, MD320, or MD351 change, remove clamps that secure electrical connector P16 to start tank emergency vent valve and disconnect electrical connector P55. (Refer to paragraph 3-43.)

g. If engine does not incorporate MD316, MD320, or MD351 change, disconnect electrical connector P16. (Refer to paragraph 3-43.)

h. Remove all support clamps from gaseous refill line.